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PHYSICOCHEMICAL FACTORS IN ANOPHELINE ECOLOGY, II: STUDIES ON TURBIDITY, CHLORIDE, AND IRON

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In a previous paper(1) I reported the results of studies on the nitrogen content of typical breeding places of *Anopheles minimus* variety *flavirostris*, the most important vector of malaria in the Philippines, and associated moving-water groups of anopheles. A brief review of the literature on physicochemical factors affecting mosquito breeding was included.

In this report are presented the results of analyses for turbidity, chloride, and total iron content of about 170 samples of water collected from the same breeding places. The procedure followed in the examinations is described in the first report.

In Table 1 are presented the occurrence and density of larvæ of *A. minimus* and associated anopheles at different degrees of turbidity. The table shows that the larvæ of these mosquitoes were usually found in clear water with turbidities ranging from 0 to 20 parts per million. However, they were also found in the same breeding places when the turbidity was temporarily increased to 400 parts per million or more at the time of observation. This temporary increase in turbidity was due to the occasional wading of men or animals along the stream or to heavy rains.

In Table 2 it will be observed that *A. minimus* and associated anopheles prefer low concentrations of chloride from mere traces to 7 parts per million. I failed to recover larvæ of these mos-

TABLE 1.—*Occurrence and intensity of anopheline breeding at different degrees of turbidity.*

Turbidity in parts per million.	*Anopheles minimus.*			*Anopheles barbirostris.*			*Anopheles aconitus.*		
	Observations.		Average larvae per dip.	Observations.		Average larvae per dip.	Observations.		Average larvae per dip.
	Total.	Positive.		Total.	Positive.		Total.	Positive.	
		P. ct.			*P. ct.*			*P. ct.*	
0– 9	20	70	1.32	20	70	1.04	20	30	0.15
10– 19	20	50	1.90	20	65	1.67	20	15	0.04
20– 29	6	50	0.42	6	50	0.20	6	0	0.0
30– 39	4	100	1.00	4	25	0.10	4	0	0.0
40– 49	4	100	2.46	4	50	1.20	4	0	0.0
50– 74	3	33	0.27	3	33	0.13	3	0	0.0
75– 99	1	100	2.00	1	100	0.40	1	100	1.50
100–149	2	50	3.70	2	0	0.00	2	0	0.00
150–199	2	100	1.60	2	0	0.00	2	0	0.00
200–249	6	67	1.57	6	33	0.17	6	0	0.00
250–299	1	0	0.00	1	100	1.50	1	0	0.00
300–399	2	100	6.00	2	50	0.30	2	0	0.00
400–499	1	100	4.00	1	100	0.40	1	100	0.20
500–699									
700–999	1	0	0.00	1	0	0.00	1	0	0.00

Turbidity in parts per million.	*Anopheles* [illegible].			*Anopheles fuliginosus.*			Unidentified.			All species.		
	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.
	Total.	Positive.		Total.	Positive.		Total.	Positive.		Total.	Positive.	
		P. ct.			*P. ct.*			*P. ct.*			*P. ct.*	
0– 9	20	10	0.05	20	0	0.00	22	50	0.59	20	80	3.15
10– 19	20	15	0.02	20	0	0.01	20	80	1.40	20	95	6.00
20– 29	5	0	0.00	5	0	0.00	6	60	0.14	5	100	0.65
30– 39	4	25	0.40	4	0	0.00	4	100	2.30	4	100	3.50
40– 49	4	0	0.00	4	0	0.00	4	75	0.95	4	100	4.50
50– 74	5	0	0.00	5	0	0.00	3	67	0.22	5	67	0.63
75– 99	1	100	0.20	1	0	0.00	1	100	1.00	1	100	6.20
100–149	2	0	0.00	2	0	0.00	3	50	1.00	2	50	4.70
150–199	2	0	0.00	2	0	0.00	2	50	0.50	2	100	3.10
200–249	6	17	0.03	6	0	0.00	6	33	0.97	6	67	2.74
250–299	1	0	0.00	1	0	0.00	1	0	0.00	1	100	1.50
300–399	2	0	0.00	2	0	0.00	2	100	5.70	2	100	12.00
400–499	1	0	0.00	1	0	0.00	1	100	1.40	1	100	8.00
500–699												
700–999	1	0	0.00	1	0	0.00	1	0	0.00	1	0	0.00

TABLE 2.—*Occurrence and intensity of anopheline breeding at different concentrations of chloride.*

Chloride in parts per million.	*Anopheles minimus.*			*Anopheles barbirostris.*			*Anopheles aconitus.*		
	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.
	Total.	Positive.		Total.	Positive.		Total.	Positive.	
		P. ct.			*P. ct.*			*P. ct.*	
(a)	7	71	1.14	7	71	1.60	7	29	0.20
0.5	1	100	3.00	1	100	4.00	1	0	0.00
1.0	13	69	1.65	13	69	1.69	13	31	0.29
2.0	7	100	1.77	7	86	1.47	7	43	0.79
3.0	7	100	2.34	7	86	1.29	7	14	0.05
4.0	7	57	1.33	7	29	0.09	7	0	0.00
5.0	3	100	3.27	3	33	0.13	3	33	0.07
6.0	8	88	2.25	8	13	0.10	8	0	0.00
7.0	6	83	1.17	6	33	0.10	6	0	0.00
8.0	4	75	0.46	4	25	0.05	4	0	0.00
9.0	2	50	0.85	2	100	0.90	2	0	0.00
10.0	2	50	0.70	2	50	0.40	2	0	0.00
11.0	1	100	10.00	1	100	0.80	1	0	0.00

Chloride in parts per million.	*Anopheles vagus.*			*Anopheles fuliginosus.*			Unidentified.			All species.		
	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.
	Total.	Positive.		Total.	Positive.		Total.	Positive.		Total.	Positive.	
		P. ct.			*P. ct.*			*P. ct.*			*P. ct.*	
(¹)	7	14	0.06	7	0	0.00	7	43	0.43	7	86	2.43
0.5	1	0	0.00	1	0	0.00	1	0	0.00	1	100	7.00
1.0	18	33	0.03	18	6	0.02	18	61	0.88	18	72	4.47
2.0	7	14	0.00	7	0	0.00	7	86	1.27	7	100	4.71
3.0	7	29	0.11	7	0	0.00	7	71	1.84	7	100	5.29
4.0	7	0	0.00	7	0	0.00	7	67	1.80	7	71	2.48
5.0	3	0	0.00	3	0	0.00	3	100	2.40	3	100	5.67
6.0	8	13	0.25	8	0	0.00	8	75	1.00	8	88	3.56
7.0	6	17	0.03	6	0	0.00	6	50	0.53	6	83	2.18
8.0	4	0	0.00	4	0	0.00	4	50	0.15	4	75	0.65
9.0	2	0	0.00	2	0	0.00	2	50	0.30	2	100	2.00
10.0	2	0	0.00	2	0	0.00	2	50	0.30	2	100	1.00
11.0	1	0	0.00	1	0	0.00	1	100	10.80	1	100	21.40

¹ Traces.

TABLE 3.—*Occurrence and intensity of anopheline breeding at different concentrations of total iron.*

Total iron in parts per million.	*Anopheles minimus.*			*Anopheles barbirostris.*			*Anopheles aconitus.*		
	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.
	Total.	Positive.		Total.	Positive.		Total.	Positive.	
		P. ct.			*P. ct.*			*P. ct.*	
0.00–0.19	7	67	0.09	7	43	0.51	7	0	0.00
0.20–0.39	8	50	0.78	8	25	0.75	8	0	0.00
0.40–0.59	8	100	2.05	8	50	0.42	8	13	0.03
0.60–0.79	9	78	2.29	9	22	0.20	9	0	0.00
0.80–0.99	2	100	1.40	2	100	0.80	2	0	0.00
1.00–1.24	2	100	1.40	2	50	0.40	2	0	0.00
1.25–1.49	1	0	0.00	1	100	0.30	1	0	0.00
1.50–1.74	2	100	0.45	2	50	0.10	2	0	0.00
1.75–1.99									
2.00–2.49	1	100	1.00	1	100	2.00	1	0	0.00
2.50–2.99									
3.00–3.99	3	0	0.00	3	0	0.00	3	0	0.00
4.00–4.99	2	50	2.50	2	0	0.00	2	0	0.00
5.00–5.99									
6.00–6.99	1	100	1.60	1	100	0.20	1	0	0.00

Total iron in parts per million.	*Anopheles vagus.*			*Anopheles fuliginosus.*			Unidentified.			All species.		
	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.
	Total.	Positive.		Total.	Positive.		Total.	Positive.		Total.	Positive.	
		P. ct.			*P. ct.*			*P. ct.*			*P. ct.*	
0.00–0.19	7	14	0.03	7	0	0	7	67	0.43	7	86	1.09
0.20–0.39	8	0	0.00	8	0	0	8	63	1.00	8	63	3.89
0.40–0.59	8	12	0.07	8	0	0	8	75	1.49	8	100	3.97
0.60–0.79	9	0	0.00	9	0	0	9	66	0.69	9	78	3.33
0.80–0.99	2	0	0.00	2	0	0	2	100	0.80	2	100	1.20
1.00–1.24	2	0	0.00	2	0	0	2	50	0.20	2	100	2.00
1.25–1.49	1	0	0.00	1	0	0	1	0	0.00	1	100	0.80
1.50–1.74	2	0	0.00	2	0	0	2	0	0.00	2	100	0.64
1.75–1.99												
2.00–2.49	1	0	0.00	1	0	0	1	100	1.60	1	100	3.40
2.50–2.99												
3.00–3.99	3	0	0.00	3	0	0	3	0	0.00	3	0	0.00
4.00–4.99	2	50	0.10	2	0	0	2	50	2.60	2	50	6.20
5.00–5.99												
6.00–6.99	1	0	0.00	1	0	0	1	100	0.80	1	100	2.40

quitoes in water having more than 11 parts per million of chloride. On the other hand, it is interesting to note that Balfour(2) reported other species of anopheles breeding in waters with a 2 to 3 per cent concentration of salt. King(3) also reported *A. subpictus* as breeding in ponds with a salt content as high as 2.8 per cent in the Philippines.

In Table 3 it will be seen that *A. minimus* and associated anopheles prefer to breed in streams with concentrations of total iron below 0.8 part per million. However, they were also

TABLE 4.—*Average turbidities in minimus breeding places classified by month and year.*

Location, month, and year.	Observations.		Average larvæ per dip.	Temperature.	Turbidity in parts per million.
	Total.	Positive.			
BULACAN		P. ct.		°C.	
July, 1931	11	35	0.25	30.7	22
August, 1931	2	0	0.00	26.0	60
September, 1931	6	0	0.00	27.4	120
October, 1931	3	33	0.40	28.3	10
November, 1931	3	100	2.93	27.7	135
January, 1932	7	86	1.71	24.5	93
February, 1932	4	75	0.80	24.4	9
March, 1932	2	100	3.00	26.4	8
April, 1932	32	100	1.68	27.1	29
May, 1932	3	100	3.10	29.6	17
June, 1932	5	40	0.34	28.8	28
July, 1932	2	0	0.00	29.1	10
August, 1932	4	0	0.00	28.4	6
October, 1932	4	0	0.00	27.9	7
December, 1932	2	0	0.00	24.3	5
May, 1933	2	100	1.70	28.5	10
March, 1934	4	40	1.10	30.1	70
LAGUNA					
January, 1932	1	0	0.00	26.0	30
March, 1932	4	100	4.90	29.2	186
May, 1932	2	100	0.90	28.2	5
February, 1933	5	80	2.50	24.3	41
March, 1933	6	80	4.20	26.4	11
June, 1933	7	50	0.84	25.6	256
January, 1934	2	100	-----	-----	46
February, 1934	3	0	0.00	22.6	[a] 700
April, 1934	3	67	0.40	20.6	10
June, 1934	3	33	0.20	26.1	200
July, 1934	2	100	1.20	27.5	107
CAVITE					
February, 1932	4	75	0.52	26.0	84
April, 1932	1	100	0.80	31.4	10
Do.	[b] 2	100	1.66	28.2	52

[a] Due to rains and flood. [b] Stagnant pools.

temporarily found in much higher concentrations during a rainy season. Williamson(4) and other workers are agreed that iron salts in high concentrations are detrimental to anopheline larvæ.

In Tables 4, 6, and 8 are presented the mean concentrations of turbidity, chloride, and total iron content classified by month and year, and in Tables 5, 7, and 9 the monthly variations in the concentration of these factors are summarized. The tables reveal marked variations in composition of water during certain months, especially in those cases affected by rains and flood, but in general it will be noted that *A. minimus* and its associated moving-water anopheles were found to breed in clear waters with small amounts of chloride and iron. Due to insufficient data I am not yet in a position to specify definitely the toleration limit to any of these physicochemical factors. However, this important problem will be made the subject of future studies.

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TABLE 5.—*Average turbidities in minimus breeding places classified by month.*

Month	Observations: Total.	Observations: Positive.	Average larvæ per dip.	Temperature.	Turbidity in parts per million.
		P. ct.		°C.	
January	10	50	1.56	24.7	33
February	20	65	1.06	25.0	a 246
March	16	80	3.48	27.6	93
April	41	56	1.25	27.4	20
May	13	73	1.05	29.3	11
June	23	62	0.48	29.8	169
July	15	60	0.38	28.6	41
August	6	0	0.00	27.2	27
September	6	0	0.00	27.4	120
October	7	14	0.17	28.1	12
November	3	100	3.98	27.7	135
December	2	0	0.00	24.0	5

a Due to rains and flood.

TABLE 6.—*Mean concentrations of chloride in minimus breeding places classified by month and year.*

Location, month, and year	Observations		Average larvæ per dip.	Temperature.	Chloride in parts per million.
	Total	Positive			
BULACAN		P. ct.		°C.	
September, 1931	4	0	0.00	27.4	1.67
October, 1931	3	33	0.46	28.2	0.67
November, 1931	3	100	3.83	27.7	0.67
January, 1932	7	86	1.71	24.6	0.86
February, 1932	4	75	0.60	26.4	1.25
March, 1932	2	100	3.50	26.4	2.00
April, 1932	32	100	1.68	27.1	2.41
May, 1932	3	100	3.[illegible]3	27.6	2.67
June, 1932	5	40	0.34	28.3	2.70
July, 1932	3	0	0.00	29.1	1.00
August, 1932	4	0	0.00	24.4	1.12
October, 1932	4	0	0.00	27.9	0.50
December, 1932	3	0	0.00	24.8	1.00
May, 1933	2	100	1.70	28.6	3.00
March, 1934	4	50	1.10	30.1	6.75
LAGUNA					
January, 1932	1	0	0.00	26.0	4.00
March, 1932	4	100	4.10	29.2	6.25
May, 1932	2	100	0.90	28.3	3.50
February, 1933	6	50	2.68	24.3	6.00
March, 1933	5	40	0.20	26.4	6.80
June, 1933	7	86	0.84	25.5	6.29
January, 1934	2	100		..	3.50
February, 1934	3	0	0.00	28.6	6.33
April, 1934	3	67	0.40	30.5	4.00
June, 1934	3	33	0.20	25.1	4.00
July, 1934	2	100	1.30	27.6	5.00
CAVITE					
February, 1932	4	75	0.52	26.6	8.25
April, 1932	1	100	0.10	31.4	8.00
Do.	a 2	100	1.55	33.2	14.50

a Stagnant pools.

TABLE 7.—*Mean concentrations of chloride in minimus breeding places classified by month.*

Month.	Observations. Total.	Observations. Positive.	Average larvæ per dip.	Temperature.	Chloride in parts per million.
		P. ct.		°C.	
January	10	40	1.60	24.7	3.60
February	20	45	1.05	25.0	6.60
March	16	30	3.40	27.6	5.62
April	42	95	1.25	27.4	3.42
May	19	79	1.05	28.5	4.47
June	24	62	0.48	28.3	4.47
July	18	40	0.38	26.6	3.60
August	5	0	0.08	27.2	1.12
September	6	0	0.50	27.4	1.57
October	7	14	0.17	26	0.62
November	3	100	2.93	27.7	0.67
December	2	0	0.00	24.8	3.00

TABLE 8.—*Mean concentrations of total iron in minimus breeding places classified by month and year.*

Location, month, and year.	Observations. Total.	Observations. Positive.	Average larvæ per d. p.	Temperature.	Total iron in parts per million.
BULACAN					
		P. ct.		°C.	
February, 1932	4	75	0.60	26.4	0.60
April, 1932	22	100	1.46	27.1	0.58
May, 1932	3	100	3.13	28.6	0.77
June, 1932	5	80	0.34	26.3	1.25
July, 1932	2	0	0.00	29.1	0.26
August, 1932	4	0	0.00	28.4	0.56
October, 1932	4	0	0.00	27.0	0.37
December, 1932	2	0	0.00	24.8	0.70
May, 1933	1	100	1.70	28.0	0.70
March, 1934	4	60	[illegible]	28.1	1.72
LAGUNA					
May, 1932	2	100	0.90	28.2	0.36
February, 1933	4	50	2.84	24.3	0.57
March, 1933	6	83	4.20	26.4	1.15
June, 1933	7	86	0.84	25.6	1.51
January, 1934	2	100		..	0.60
February, 1934	5	0	0	22.6	[a]10.57
April, 1934	3	67	0.40	29.5	1.30
June, 1934	3	33	0.20	25.1	2.50
July, 1934	2	100	1.10	27.5	4.55
CAVITE					
February, 1932	8	75	0.62	28.0	0.60

[a] Due to heavy rains and flood.

Table 9.—*Mean concentrations of total iron in minimum breeding places classified by month.*

Month.	Observations.		Average larvae per dip.	Temperature.	Total iron in parts per million.
	Total.	Positive.			
		Per ct.		°C	
January	14	50	1.05	24.7	0.50
February	20	65	1.04	25.0	a 0.10
March	16	63	3.40	27.6	1.38
April	41	90	1.25	27.4	0.65
May	19	79	1.05	28.2	0.62
June	22	63	0.45	28.3	1.74
July	10	40	0.35	26.6	2.22
August	6	0	0.00	27.2	0.94
October	7	14	0.17	28.1	0.28
December	2	0	0.00	24.8	0.79

a Due to [illegible].

NEODIPLOSTOMUM LARAI, A NEW TREMATODE PARASITE OF THE CATTLE EGRET[1]

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TWO PLATES

The family Alariidæ (Tubangui, 1922) Bosma, 1931, has so far only three species representing two genera in this country. They are *Procaria butasturina* Tubangui, 1932, *Neodiplostomum aluconi* Tubangui, 1933, and *N. crocodilarum* Tubangui and Masiluñgan, 1936, obtained from the small intestine, respectively, of *Butastur indicus*, *Aluco longimembris*, and *Crocodilus porosus*. This family is further enriched by our finding in the same organ of *Bubulcus ibis coromandus* (Boddaert) of a hitherto unknown species which seems to answer La Rue's specifications (1926) for *Neodiplostomum* Railliet. For this new *Neodiplostomum* we propose the name *Neodiplostomum larai*, in honor of Dr. Hilario Lara, secretary and acting director of the School of Hygiene and Public Health, University of the Philippines, in grateful acknowledgment of his interest in the development of parasitology in this country.

NEODIPLOSTOMUM LARAI sp. nov. Plates 1 and 2.

This description is based on a study of fifteen specimens from the small intestines of *Bubulcus ibis coromandus* (Boddaert), caught around Laguna de Bay, a body of fresh water a few miles south of Manila.

Body small, ventrally bent, 0.81 to 1.28 mm in length, divided by a constriction into two body regions of which the anterior portion is about twice as long as the posterior. Forebody foliaceous, delicate, 0.55 to 0.81 mm by 0.25 to 0.43 mm; the posterior portion of the lateral borders ventrally inrolled, uniting with each other behind hold-fast organ or haptor (Price, 1934) making a free underhanging margin (Plate 1, fig. 1). Cuticle smooth. Oral sucker subterminal, 0.035 mm across;

[1]Aided by a special research grant from the Board of Regents, University of the Philippines. Received for publication November 28, 1936.

acetabulum behind middle of forebody, 0.03 to 0.04 mm in diameter. Pharynx muscular, 0.08 by 0.02 mm; œsophagus short, 0.052 mm long; intestinal ceca simple, their blind ends terminating a variable distance from the posterior border of anterior testis to middle of seminal vesicle. Hold-fast organ, or haptor, roughly ovoid, 0.14 to 0.19 mm by 0.10 to 0.17 mm, between acetabulum and underhanging margins of forebody, extending laterally beyond limits of intestinal ceca. Adhesive glands paired, oval, 0.03 to 0.09 mm by 0.02 to 0.04 mm, posterodorsal to haptor, their caudal ends usually diverging from each other. Suctorial cups, or earlike appendages, absent.

Hind body semicylindrical, 0.26 to 0.47 mm by 0.17 to 0.22 mm, bearing the bulk of the reproductive organs, dragging the copulatory bursa behind. Bursa copulatrix posterodorsal, prominent, 0.088 to 0.11 mm long with the transverse diameter (0.075 to 0.15 mm) greatest behind its middle; with lateral lips dorsally incurved but never uniting with each other, forming an incomplete cup which envelopes a central, caudally directed genital cone, 0.028 by 0.024 mm (Plate 2, figs. 1 and 2).

Female organs.—Ovary transversely oval, 0.04 to 0.08 mm by 0.03 to 0.07 mm, in front of transverse branch of anterior testis, median or slightly towards the left side of the median line, near junction of two body regions. Oviduct could not be made out. Mehlis's gland longitudinally oval, 0.08 by 0.07 mm in front of middle of hind body on left side, lying between and partly overlapped by the left arms of the testes. Uterus usually projects anterodorsally from near right side of Mehlis's gland to a short distance behind ovary, then, bending sharply under itself, it proceeds posteriad gradually narrowing in caliber near neck of seminal vesicle to form the vagina which penetrates the genital cone enveloped by the copulatory bursa. Vitellaria made up of irregularly shaped follicles abundant in the hind body, extending from shortly behind posterior testis to as far forward as middle of forebody gradually fading out in front of acetabulum.

Male organs.—Testes tandem, large, crowding out hind body. Anterior testis transversely and irregularly T-shaped, chiefly postovarial, with lateral arms (transverse arm 0.07 by 0.081 mm, longitudinal, 0.19 by 0.081 mm), directed ventrally the longitudinal arm partly overlapped by right branch of posterior testis. Posterior testis irregularly V-shaped, each arm (0.19 by 0.09 mm) directed somewhat anterodorsally, the right partly

covering the anterior testis and the left arm together with the transverse branch of the anterior testis partly overlapping Mehlis's gland. Vasa efferentia and vas deferens could not be made out. Seminal vesicle ovoid, 0.08 by 0.06 mm, chiefly confined to right side of hind body, may or may not be partly covered by posterior testis (depending upon the degree of distention) and discharges behind through a short ejaculatory duct which joins the vagina before the latter enters the genital cone.

Eggs oval, brown, thin-shelled, operculated, 70 to 81 μ by 53 to 74 μ. Excretory system not clearly determined.

Specific diagnosis.—Neodiplostomum: Total length, 0.81 to 1.28 mm., forebody foliaceous, 0.55 to 0.81 mm by 0.25 to 0.43 mm; hind body semicylindrical, 0.26 to 0.47 mm by 0.17 to 0.22 mm, bearing the bulk of the reproductive organs. Ovary transversely oval, 0.04 to 0.08 mm by 0.03 to 0.07 mm, median or slightly towards left side of median line, in front of transverse branch of anterior testis. Mehlis's gland oval, 0.08 by 0.07 mm, anterior to middle half of hind body, partly overlapped by the left arms of the testes. Vitellaria most abundant in hind body, extending from behind posterior testis to middle of forebody, gradually fading out in front of acetabulum. Anterior testis mostly postovarial, irregularly and transversely T-shaped, with longitudinal (0.19 by 0.81 mm) and transverse (0.07 by 0.08 mm) branches directed ventrally; posterior testis irregularly V-shaped, each arm (0.19 by 0.08 mm) directed anterodorsally. Seminal vesicle behind posterior testis, ejaculatory duct short, joins vagina before latter enters genital cone. Eggs brown, thin-shelled, 70 to 81 μ by 53 to 74 μ.

Host.—Bubulcus ibis coromandus (Boddaert).

Location.—Small intestine.

Locality.—Biñan, Laguna Province, Luzon.

Type specimen.—Parasitological collection, Department of Parasitology, School of Hygiene and Public Health, University of the Philippines.

Remarks.—Our species most closely resembles *Neodiplostomum orchilongum* Noble, 1936 from which it differs in the following respects: (a) the anterior testis is chiefly postovarial, and has the form of a transverse irregular T with the longitudinal and transverse arms directed ventrally. The anterior testis of *N. orchilongum* on the other hand may be described as a small segment of a thick spiral, situated chiefly in the anterior left portion of the hind body and entirely to the left of the ovary

and Mehlis's gland, with the most posterior portion lying farthest to the left of the body and the most anterior portion reaching the anterior limits of the hind body, closely applied to Mehlis's gland; (*b*) the posterior testis has the form of an irregular V, with the arms directed anterodorsally. The corresponding testis of *N. orchilongum* is very atypical in shape, being elongated and twisted in such a manner that the anterior portion lies ventrally on the right side of the body while a more elongated projection extends diagonally along the left side with the posterior termination curving slightly to the right and reaching the dorsal body wall; (*c*) Mehlis's gland, which never reaches the ovary in our specimens, lies between and is partly overlapped by the left branches of the testes, instead of lying on the right side of the hind body between the anterior testis and the ovary, with the anterior and ventral margins usually projecting beyond corresponding limits of the latter organ in *N. orchilongum*; and (*d*) the vitellaria in our specimens are irregularly distributed in the hind body, and never confined to two compact relatively massive ventral columns as they are in *N. orchilongum*.

ACKNOWLEDGMENT

We are greatly indebted to Dr. Marcos A. Tubangui, of the Bureau of Science, for his valuable suggestions, and to Dr. Candido M. Africa, head of the Department of Parasitology, School of Hygiene and Public Health, University of the Philippines, for his kindness in going over this paper.

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ILLUSTRATIONS

(Abbreviations: *ac*, acetabulum; *ag*, adhesive gland; *bc*, bursa copulatrix; *esc*, excretory space; *gc*, genital cone; *hf*, holdfast organ, or haptor; *int*, intestine; *mg*, Mehlis's gland; *oes*, oesophagus; *os*, oral sucker; *ov*, ovary; *ph*, pharynx; *t*, *t*, testes; *utd*, descending limb of uterus; *vag*, vagina; *vg*, vitelline glands; *vs*, seminal vesicle.)

PLATE 1

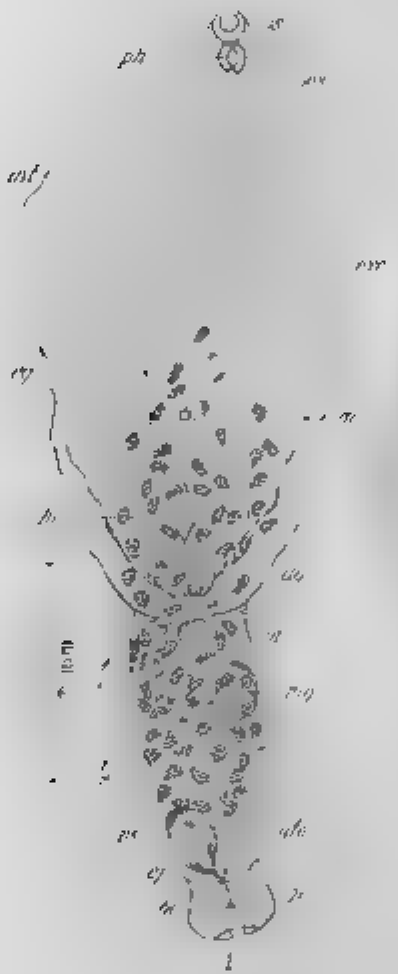
FIG. 1. *Neodiplostomum lucai* sp. nov., camera-lucida drawing of the entire worm, ventral view. (Drawn by H. Holda.)

2. *Neodiplostomum lucai* sp. nov., microphotograph of entire worm, dorsal view, low power, × 100.

PLATE 2

FIG. 1. *Neodiplostomum lucai* sp. nov., bursa copulatrix, microphotograph, dorsal view, high power, × 450.

2. *Neodiplostomum lucai* sp. nov., bursa copulatrix, drawn from fig. 1, Plate 2, dorsal view, × 450.



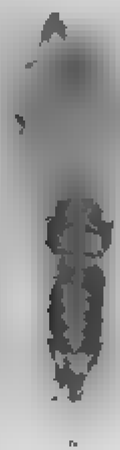
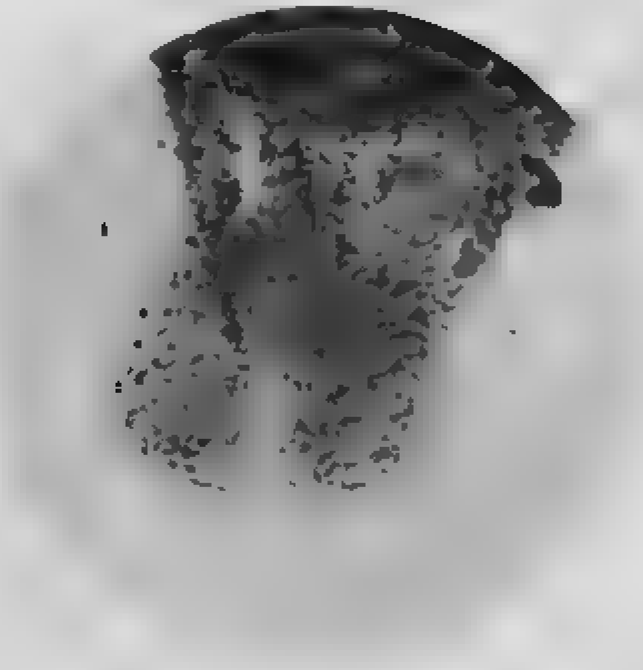


PLATE 1.



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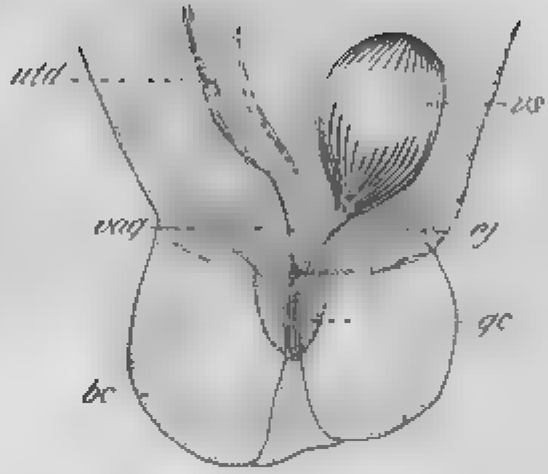

2

PLATE 2

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XXXIV[1]

By Charles P. Alexander
Of Amherst, Massachusetts

ONE PLATE

The crane flies discussed at this time were collected by Mrs. M. E. Walsh in southeastern Sumatra and in various parts of Java. I am very much indebted to Mrs. Walsh for her appreciated interest in saving specimens of these flies when on collecting expeditions to remote parts of the Malayan islands. The types of the novelties are preserved in my collection of Tipulidæ.

The localities where the specimens were taken have been briefly discussed by Mrs. Walsh:

Tandjong Sakti, Benkoelen, southeastern Sumatra, altitude 1,650 to 2,000 feet, May 24 to June 30, July 16 to 19, 1935.

Boekit Djam, Benkoelen, altitude 1,000 to 2,000 feet, June 11 to 15, June 18, June 24 to July 2, 1935.

Moeara Tenam, Benkoelen, June 16 to 23, July 4 to 14, 1935.

Poeloe Panas, Benkoelen, altitude 2,500 feet, June 1 to 4, 1935.

Tanggamoes, Lampangs, altitude 1,500 to 2,000 feet, July 22 to August 5, 1935.

Tjolo, northern Java, altitude about 2,100 feet, on the Goenoeng Moeria, where the Pasangrahan is located, December 1 to 8, 1935.

Goenoeng Moeria, northern Java, a mountain with seven tops, quite isolated from the central chain of the island by an immense alluvial plain, altitude 3,000 to 4,000 feet, December, 1935.

Nglirip, central Java, a small village in the djati forests, between Rembang and Bodjanegoro, altitude about 300 feet, January 1 to 7, 1936.

Soember Brantas, east Java, Mount Ardjano, on a pass between Ardjano and Audjarmoro, altitude 6,000 feet, January 14 to 25, 1936.

[1] Contribution from the entomological laboratory, Massachusetts State College.

portion of head brownish gray, the anterior vertex with a linear velvety black median line that extends high on to the simple vertical tubercle.

Pronotum dark brown, paler medially. Mesonotal præscutum with the interspaces brownish yellow, a little brighter in front, the lateral borders of the sclerite light gray pruinose; three subopaque blackish stripes that are narrowly bordered by deeper black, especially the median stripe; scutal lobes dull black, the median area restrictedly paler; scutellum obscure yellow; mediotergite pale in color, clear light gray pruinose, the posterior border with two dusky areas. Pleura weakly pruinose, vaguely marked with darker on anepisternum and ventral sternopleurite, the pteropleurite and pleurotergite light gray. Halteres with stem brownish yellow, brighter at extreme base, the knob infuscated. Legs with fore coxæ darkened on cephalic face, the remainder of coxæ paler, the surface heavily pruinose; trochanters yellow; femora obscure yellow, the tips scarcely darkened but tufted with a group of black setæ; tibiæ and tarsi passing through brown to black. Wings (Plate 1, fig. 2) subhyaline, cell Sc clear light yellow; stigma small, pale brownish yellow; veins dark brown, the prearcular area and veins Sc and R more yellowish. Venation: Anterior cord rather strongly bowed; medial forks deep.

Abdominal tergites obscure yellow, the intermediate and outer segments brighter yellow, narrowly bordered laterally with deep velvety black; central portion of each tergite occupied by a black quadrate area; sternites uniformly light yellow; genital shield intensely black; cerci horn-colored, straight, the apices obtuse.

Habitat.—Sumatra (Benkoelen).

Holotype, female, Boekit Jtam, altitude 1,000 to 2,000 feet, June 11 to 15, 1935 (*Walsh*).

The nearest ally seems to be *Scamboneura quadrata* de Meijere, from Kambangan Island, south of western Java. The latter species differs in numerous details of color, as the yellow antennal scape, uniformly blackish brown flagellum, the reddish brown median præscutal vitta, blackish brown mediotergite with broad lateral borders, and the blackish blue areas on the abdominal tergites. The present fly is the most westerly species as yet discovered.

NEPHROTOMA NIGRITHORAX (de Meijere)

Pachyrrhina nigrithorax DE MEIJERE. Bijd. tot de Dierkunde 21 (1919) 18.

The type, a female, was from Air Njuruk, Dempu, Palembang, Sumatra, altitude 4,550 feet, collected in August by Jacobson.

SUMATRA, Goenoeng Singgalang, altitude 5,200 feet, 1926 (*Jacobson*), Brastagi, May, 1918 (*J. B. Corporaal*). WEST JAVA, Tjibodas, Mount Gedeh, altitude 4,200 feet, April 2, 1934 (*Walsh*).

The Javan specimen is very similar to the Sumatran material, except that the femora are more extensively blackened, including the outer two-thirds or more of the segment.

TIPULA TJIBODENSIS Alexander

Tipula tjibodensis ALEXANDER, Proc. U. S. Nat. Mus. 49 (1916) 186; Philip. Journ. Sci. 57 (1935) 86.

The types were from Tjibodas, Mount Gedeh, west Java

Three females, Goenoeng Moeria, north Java, altitude 3,000 to 4,000 feet, December, 1935 (*Walsh*)

LIMONIINÆ

LIMONIINI

LIMONIA (LIBNOTES) LEUCOTHORAX sp. nov. Plate 1, fig. 3.

Thorax entirely pale yellow, unmarked; head black, eyes holoptic; antennæ black, the flagellar verticils of unusual length; legs brown; wings whitish subhyaline, the prearcular and costal regions clear light yellow; stigma oval, brown, conspicuous; Rs about twice as long as the basal section of R_{4+5}; cell 1st M_2 rectangular, relatively small, shorter than any of the veins beyond it; cell 2d A narrow.

Male.—Length, about 7.5 millimeters; wing, 9.

Rostrum brown; palpi brownish black. Antennæ with scape brown; pedicel and flagellum black; flagellar segments oval to cylindrical, the more basal segments with short glabrous apical pedicels; longest verticils of outer segments of unusual length, exceeding three times the length of the segments; terminal segment one-half longer than the segment. Head black, the surface subnitidous, eyes holoptic, eliminating the anterior vertex.

Thorax entirely pale yellow, immaculate. Halteres with stem pale yellow, the knob weakly darkened. Legs with the coxæ

and trochanters yellow; femora brown, the bases somewhat more brightened; tibiæ and tarsi pale brown. Wings (Plate 1, fig. 3) whitish subhyaline, the prearcular and costal regions clear light yellow; stigma oval, brown, conspicuous; veins pale brownish yellow, brighter in the yellow areas. Venation: Sc relatively long, Sc_1 ending about opposite r-m, somewhat swollen at end; Sc_2 far from tip of Sc_1, before fork of Rs; Rs about twice the basal section of R_{4+5}; free tip of Sc_2 and R_2 in transverse alignment; cell 1st M_2 rectangular, relatively small, shorter than any of the veins beyond it, with m-cu shortly before midlength, anal veins divergent, cell 2d A narrow.

Abdominal tergites dark brown, the segments obscure yellow laterally; sternites and hypopygium obscure yellow.

Habitat.—Central and east Java.

Holotype, male, Mount Ardjuno, east Java, altitude 6,000 to 7,000 feet, January, 1936 (*Walsh*). Paratype, 1 male, Ngarip, central Java, altitude 300 feet, January 1 to 7, 1936 (*Walsh*).

By Edwards's key to the species of the subgenus *Libnotes* [3] the present fly runs to couplet 61, disagreeing with all species beyond this point by the coloration of the thorax. It is most nearly allied to species such as *subfamiliaris* Alexander, yet differs in the pattern of the thorax and wings.

LIMONIA (LIBNOTES) CLAUDA sp. nov. Plate 1, fig. 4.

Mesonotal præscutum almost covered by a polished black discal shield; halteres and legs blackened; wings with a strong dusky tinge, especially on outer part of wing; cells C and Sc, together with the stigma, more blackened; r-m unusually oblique, Rs about two and one-half times the basal section of R_{4+5}; cell 1st M_2 small, m about twice the basal section of M_3; m-cu beyond midlength of cell 1st M_2, cell 2d A narrow, abdominal tergites uniformly dark brown.

Female.—Length, about 8 millimeters; wing, 9.

Head broken.

Pronotum brownish black medially, obscure yellow on sides. Mesonotal præscutum chiefly covered by a polished black discal shield comprised of the three entirely confluent stripes, the obscure yellow ground color restricted to the humeral and lateral portions; scutal lobes black, the median area paler; scutellum and mediotergite dark brown. Pleura obscure yellow, the ventral sternopleurite a little infuscated. Halteres black-

[3] Journ. Fed. Malay States Mus. 14 (1928) 74–80.

ened, the base of stem restrictedly pale. Legs with the coxæ and trochanters yellow; remainder of legs brownish black, the femoral bases scarcely brightened Wings (Plate 1, fig 4) with a strong dusky tinge, cells C and Sc, together with the stigma, more blackened; cells beyond the cord slightly more infumed than those of basal portion of wing; veins black. Venation: Sc relatively long, Sc_1 ending nearly opposite the outer end of the unusually oblique r-m; Sc_2 opposite fork of Rs, the latter about two and one-half times the basal section of R_{4+5}; free tip of Sc_2 and R_2 in transverse alignment, both pale; cell 1st M_2 small, m about twice the basal section of M_3; m-cu beyond midlength of cell 1st M_2 and longer than the distal section of Cu_1; cell 2d A narrow

Abdominal tergites uniformly dark brown; sternites obscure yellow, the outer segments a little darker

Habitat.—East Java

Holotype, female, Mount Ardjano, altitude 6,000 to 7,000 feet, January, 1936 (*Walsh*).

The nearest ally of the present fly seems to be *Limonia* (*Libnotes*) *luteithorax* sp. nov., both species having cell 2d A of the wings unusually narrow, much more so than in related species. The present fly differs further in the blackened præscutal disk, the strongly infuscated wings, and in the venational details, as the unusually oblique r-m and the relative proportions of veins m and the basal section of M_3. By Edwards's key to the species of *Libnotes*[3] the fly runs to couplet 63, disagreeing with all species beyond this point in the characters diagnosed above.

LIMONIA (PSEUDOGLOCHINA) QUERULA sp. nov. Plate 1, fig. 5.

Mesonotum dark brown; antennæ relatively long, the flagellar segments with conspicuous apical pedicels; pleura chiefly covered by a very broad, pale, longitudinal stripe; halteres black; tibiæ with a single narrow dark ring; wings with a faint dusky tinge, the wing tip and cord faintly seamed with darker, Sc_1 ending beyond the fork of Rs, Sc_2 about opposite the origin of this vein, m-cu close to fork of M; vein 2d A relatively long and extended.

Male.—Length, about 6.6 millimeters; wing, 6.8.

Rostrum brown; palpi black. Antennæ relatively long, black throughout; flagellar segments subcylindrical, with conspicuous

[3] Loc. cit.

apical pedicels, segments with a dense erect pubescence and long, unilaterally arranged verticils. Head brown.

Pronotum yellow. Mesonotum dark brown, the præscutum paler medially before suture, posterior sclerites of notum slightly pruinose. Pleura chiefly occupied by a very broad, pale, longitudinal stripe extending from the prothorax to the base of abdomen, the stripe slightly narrowed behind, the posterior portion a little pruinose; pleurotergite and ventral sternopleurite black. Halteres black. Legs with the coxæ and trochanters black, the fore coxæ a little brightened at base; fore femora yellow, the tips narrowly brownish black; midfemora black, with a narrow, obscure yellow, subterminal ring; posterior femora uniformly black; tibiæ and tarsi snowy white, the former with a single narrow blackened ring at near midlength. Wings (Plate 1, fig. 5) with a very faint dusky tinge, stigma subcircular, dark brown; wing tip and narrow seams along cord pale brown; veins brownish black to black. Trichia of veins long and coarse. Venation: Sc relatively long, Sc_1 ending beyond fork of Rs, Sc_2 opposite to just before origin of Rs; basal section of R_{4+5} arcuated; R_{2+3} about two-thirds the length of vein R_3 alone; medial forks relatively deep; m-cu close to fork of M; vein 2d A relatively long and extended.

Abdominal tergites bicolorous, dark brown, the segments brownish yellow before apices, sternites more clearly bicolorous, the caudal margin broadly yellow; hypopygium dark.

Habitat.—East Java.

Holotype, male, Nongkodjadjar, Tengger Mountains, altitude 3,600 feet, February, 1936 (*Walsh*).

Limonia (*Pseudoglochina*) *querula* is most nearly related to *L.* (*P.*) *angustapicalis* Alexander (Luzon). The latter has the halteres and the posterior femora differently colored and with the venational details distinct, as the shorter petiole of cell 2d M_2 and the less-extended vein 2d A. The pale but evident dark seam along the wing cord of the present fly is not found in *angustapicalis*.

LIMONIA (PSEUDOGLOCHINA) UNICINCTIPES Alexander.

Limonia (*Pseudoglochina*) *unicinctipes* ALEXANDER, Philip. Journ. Sci. 40 (1929) 336–337.

Recorded from the Philippines and Borneo.

One female, Soekaboemi, west Java, altitude 1,800 feet, February, 1934 (*Walsh*).

LIMONIA (PSEUDOGLOCHINA) KOBUSI (de Meijere).

Dicranomyia kobusi DE MEIJERE, Bijd. tot de Dierkunde 18 (1904) 91-92.

EAST JAVA, Nglirip, altitude 800 feet, January, 1936 (*Walsh*).

HEXATOMINI

PSEUDOLIMNOPHILA NYCTERIS sp. nov. Plate 1, fig. 6.

Thorax intensely black; antennæ black throughout, the flagellar verticils very long; halteres dusky; legs dark brown to brownish black, the femoral bases obscure yellow; wings strongly tinged with yellowish brown, stigma very small, darker brown; costal fringe relatively long and very dense, Sc_1 ending just beyond fork of Rs; R_{1+2} about twice R_2 alone; cell M_1 present, shorter than its petiole; m-cu at near one-third the length of the rectangular cell 1st M_2; abdominal tergites black.

Male.—Length, about 8 millimeters; wing, 7.

Rostrum and palpi dark brown. Antennæ black throughout; basal flagellar segments long-oval, the outer segments more cylindrical; verticils of outer flagellar segments very long and conspicuous, the longest about two and one-half times the length of the segments. Head dark brown; anterior vertex wide, slightly exceeding twice the diameter of the scape.

Pronotum and mesonotum black, the mediotergite slightly pruinose. Pleura, including the pleurotergite and dorsopleural membrane, black. Halteres dusky. Legs with the coxæ black, the middle coxæ somewhat paler; trochanters obscure yellow; femora brownish black, the bases obscure yellow; tibiæ and tarsi dark brown. Wings (Plate 1, fig. 6) with a strong yellowish brown tinge, more saturated in outer radial field, costal region slightly more yellowish; stigma very small, darker brown; veins brown. Costal fringe (male) relatively long and very dense. Venation: Sc_1 ending just beyond fork of Rs, Sc_2 near its tip; R_{1+2} about twice R_2 alone; cell M_1 present, shorter than its petiole; cell 1st M_2 rectangular, with m-cu at near one-third its length; cell 2d A wide; anterior arculus preserved.

Abdominal tergites black, the sternites obscure brownish yellow; hypopygium dark.

Habitat.—Sumatra (Benkoelen).

Holotype, male, Tandjong Sakti, altitude 1,650 to 2,000 feet, May 24 to 31, 1935 (*Walsh*).

Pseudolimnophila nycteris is readily told from other regional species by the intense black color of the entire thoracic region.

Genus HEXATOMA Latreille

Hexatoma Latreille, Gen. Crust. et Ins. 4 (1809) 260.

Subgenus ERIOCERA Macquart

Eriocera Macquart, Dipt. exot. 1, 1 (1838) 74.

The very extensive group *Eriocera* is well represented in the Oriental Region. At this time I am describing several new species from Java and southeastern Sumatra, and further take the opportunity to provide additional data concerning the distribution of several other members of the subgenus from the same area.

HEXATOMA (ERIOCERA) SUBAURANTIA sp. nov. Plate 1, fig. 7.

Belongs to the *rubrescens* group; body almost uniformly orange; a circular dark brown spot on extreme dorsal anepisternum immediately before wing root; legs chiefly dark brown; wings fulvous brown, stigma small, darker brown, veins beyond cord with abundant macrotrichia; veins R_{1+2} and R_2 subequal; cell M_1 about twice as long as its petiole; cell 1st M_2 long-rectangular, twice as long as wide, with m-cu at near midlength.

Female.—Length, about 12 millimeters; wing, 11.

Rostrum yellow, palpi black. Antennæ 8-segmented (female), scape yellow, pedicel and flagellum brownish black; flagellar segments gradually decreasing in length to the end. Head entirely orange; vertical tubercle broad and low, virtually simple; a few scattered black setæ on vertex.

Mesonotum uniformly orange, immaculate; præscutal setæ very sparse, tiny, and pale. Pleura orange-yellow, with a circular dark brown spot on extreme dorsal anepisternum, immediately before wing root. Halteres dark brown throughout. Legs with the coxæ and trochanters orange; femora obscure yellow basally, passing into dark brown; tibiæ dark brown; outer tarsal segments a little paler. Wings (Plate 1, fig. 7) with a strong fulvous-brown suffusion, cell Sc clearer yellow; stigma very small, long-oval, darker brown; veins yellowish brown to brown. Abundant macrotrichia on veins beyond cord, excepting R_{1+2} and distal section of Cu_1. Venation: Sc_1 ending nearly opposite fork of R_{2+3+4}; veins R_{1+2} and R_2 subequal, either less than one-half R_{2+3}; R_{2+3+4} and R_{3+4} subequal; basal section of vein R_5 shorter than r-m; cell M_1 present, nearly twice as long as its petiole; cell 1st M_2 long-rectangular, twice as long as wide,

exceeding vein M_3 beyond it; m-cu at near midlength of cell, longer than distal section of Cu_1.

Abdomen orange, without markings or differentiated basal rings; valves of ovipositor elongate.

Habitat.—Sumatra (Benkoelen).

Holotype, female, Tandjong Sakti, altitude 1,650 to 2,000 feet, June 11 to 20, 1935 (*Walsh*).

By Edwards's key to the Old World species of *Eriocera*[4] the present fly runs to couplet 31, where it agrees most nearly with *Hexatoma* (*Eriocera*) *aurantia* (Brunetti) of the eastern Himalayas. The latter species differs conspicuously in several details of body-coloration, but especially in the coloration and venation of the wings, as the lack of a stigma and the short and broad cell 1st M_2 which is only a little longer than wide. It should be noted that in *aurantia* R_{1+2} is nearly twice as long as vein R_2, disagreeing with couplet 27 of Edwards's key.

HEXATOMA (ERIOCERA) KARNYI Edwards.

Eriocera karnyi EDWARDS, Treubia 6 (1925) 167.

WEST JAVA, Mount Djampangs, Tengeh, altitude 1,500 to 2,000 feet, March, June, September, 1933; February, May, 1934 (*Walsh*). Soekaboemi, altitude 1,800 feet, February, April, 1934 (*Walsh*).

HEXATOMA (ERIOCERA) FERRUGINOSA (van der Wulp).

Eriocera ferruginosa VAN DER WULP, Notes Leyden Mus. 7 (1885) 13.

WEST JAVA, Mount Djampangs, Bodjang Kalang, September, 1935 (*Walsh*). Soekaboemi, altitude 1,800 feet, March, 1933 (*Walsh*).

HEXATOMA (ERIOCERA) COMMODA sp. nov.

Belongs to the *dichroa* group; size large (wing, male, 20 millimeters or more); mesonotal præscutum with four reddish stripes that are narrowly bordered by black; legs black, wings brown, cells C and Sc conspicuously more yellowish; veins R_{1+2} and R_{2+3+4} subequal; cell 1st M_2 rectangular, nearly twice as long as wide, with m-cu at or beyond midlength; abdominal segments two to five deep orange to reddish brown, the subterminal segments blackened.

Male.—Length, about 19 to 23 millimeters; wing, 18 to 23.

Female.—Length, about 20 to 24 millimeters, wing, 15 to 19.

[4] Ann. & Mag. Nat. Hist. IX 8 (1921) 70-78.

Rostrum black, pruinose; palpi black. Antennæ of male 7-segmented, of female 9-segmented; scape brownish black, sparsely pruinose; pedicel dark brown; basal segment of flagellum brownish yellow, the outer segments black. Head black, sparsely pruinose, especially on sides of posterior vertex; vertical tubercle (male) simple but very conspicuous; setæ of head sparse but conspicuous, black.

Mesonotum with the ground color obscure brownish gray, with four reddish stripes that are narrowly bordered by black; posterior interspaces with conspicuous appressed yellow setæ; posterior sclerites of mesonotum black, the centers of the scutal lobes reddish. Pleura deep reddish brown to liver brown; setæ sparse, restricted to mesepisternum. Halteres with stem dark brown, the knob blackened. Legs with the coxæ and trochanters dark brown; remainder of legs black. Wings long and relatively narrow, almost uniformly suffused with brown; cells C and Sc conspicuously more yellowish; no stigma; veins brown, more yellowish in the costal region. Trichia of veins beyond cord exceedingly sparse and scattered, but including veins R_{1+2}, R_3, R_4, R_5, and M_1. Venation: Sc_1 ending opposite R_2, its tip strongly arcuated to angulated and weakly spurred, the latter condition in the female sex; Sc_2 just beyond fork of R_{2+3+4}; veins R_{2+3} and R_{2+3+4} subequal or nearly so; cell M_1 from one and one-half to nearly two times its petiole; cell 1st M_2 rectangular, nearly twice as long as wide, with m-cu at or beyond midlength.

Basal abdominal tergite dark brown; tergites two to five, inclusive deep orange to reddish brown, succeeding segments darker brown to brownish black; sternites more uniformly pale; no differentiated glabrous rings on segments; hypopygium brownish yellow.

Habitat.—Sumatra (Benkoelen).

Holotype, male, Moeara Tenam, June 16 to 23, 1935 (*Walsh*). Allotopotype, female, July 4 to 14, 1935 (*Walsh*). Paratopotypes, 6 males and females, with the holotype.

By Edwards's key to the Old World species of the subgenus[1] the present fly runs to *Hexatoma* (*Eriocera*) *ferruginosa* (van der Wulp), which appears to be its closest ally. The present species differs most evidently in the uniformly black legs and distinct venation, as the much deeper forks beyond the cord, longer petiole of cell M_1, distal position of m-cu, and other

[1] Loc. cit.

characters. In *ferruginosa* the trichia of the outer radial veins are very numerous.

HEXATOMA (ERIOCERA) PENNULATA (Enderlein).

Eriocera pennulata ENDERLEIN, Zool. Jahrb. Syst. 32 (1912) 43-44.

SUMATRA, Moeara Tenam, Benkoelen, July 4 to 14, 1936 (*Walsh*).

JAVA, Goenoeng Moeria, north Java, altitude 3,000 to 4,000 feet, December, 1935 (*Walsh*). Sindanglaija, altitude 4,000 to 5,000 feet (*Frederick Muir*).

HEXATOMA (ERIOCERA) VERTICALIS (Wiedemann).

Megalocera verticalis WIEDEMANN, Aussereur. zweifl. Ins. 1 (1828) 56.

WEST JAVA, Mount Djampangs, altitude 1,500 to 2,000 feet, March, May, 1933; April, 1934 (*Walsh*).

HEXATOMA (ERIOCERA) PLUTONIS sp. nov. Plate 1, fig. 8.

Size small (wing, 8.5 millimeters); general coloration velvety black, the præscutum with three polished black stripes; halteres and legs black; wings narrow, strongly tinged with blackish; outer veins of wing with abundant macrotrichia; veins R and R_3 subequal; R_{2+3+4} subequal to R_{1+2}; cell M_1 present; m-cu at or close to fork of M_{3+4}; abdomen black, the segments with nacreous or slightly pruinose basal rings.

Male.—Length, about 9 millimeters; wing, 8.5

Female.—Length, about 9.5 millimeters; wing, 8.5

Rostrum and palpi black. Antennæ of male 8-segmented, black throughout; flagellar segments gradually decreasing in length, the last about two-thirds the penultimate. Head velvety black.

Pronotum black. Mesonotal præscutum velvety black, with three more polished black stripes, without pruinosity scutum velvety black, the centers of the lobes similarly polished black; posterior sclerites of notum black. Pleura polished black. Halteres relatively elongate, black throughout. Legs slender; coxæ black; trochanters dark brown; remainder of legs black, the femoral bases somewhat brightened. Wings (Plate 1, fig. 8) relatively narrow, with a strong blackish tinge, the axillary region a little brightened; veins darker than the ground color. Abundant macrotrichia on veins beyond cord. Venation: Sc_1 ending a short distance beyond r-m; Rs of moderate length, subequal to R, arcuated at origin; R_{2+3+4} subequal to R_{1+2} and a

little longer than R_{2+3}; cell M_1 present, subequal to its petiole; m-cu at fork of M_{3+4} (male) or some distance before this fork, at near three-fourths the length of cell 1st M_2 (female).

Abdomen black, the basal portions of the more proximal tergites more nacreous and pruinose; sternites with the pruinose bases more extensive, only a little less in degree than the velvety black apical portions; hypopygium brownish black. Genital shield of female brown; valves of ovipositor horn yellow.

Habitat.—Sumatra (Benkoelen).

Holotype, male, Bockit Jtam, altitude 1,000 to 2,000 feet, June 11 to 15, 1935 (*Walsh*). Allotopotype, female. Paratopotype, female.

By Edwards's key to the species of *Eriocera*[4] the present fly runs to *Hexatoma* (*Eriocera*) *hygropis* (Alexander) of Formosa, a large, powerfully built crane fly that is not closely allied to the present insect. This latter is one of the smallest and most delicate members of the subgenus in the Oriental fauna.

HEXATOMA (ERIOCERA) CANINOTA sp. nov. Plate 1, fig. 9.

Size small (wing, female, 9 millimeters); general coloration velvety black, the præscutum with three nearly confluent, silvery-gray stripes, scutal lobes similarly silvery pruinose; antennæ of female 8-segmented, black throughout; legs and halteres black, the femoral bases restrictedly brightened, especially the posterior pair; wings black; veins beyond cord with abundant macrotrichia; R_{3+4} shorter than R_{2+3} and subequal to R_{1+2}; cell M_1 present, about as long as its petiole; m-cu at near midlength of the rectangular cell 1st M_2; abdomen velvety black, the basal rings of the segments more nacreous; genital shield fiery orange.

Female.—Length, about 11 millimeters; wing, 9.

Rostrum very short, black; palpi black. Antennæ (female) 8-segmented, black throughout; flagellar segments gradually decreasing in length outwardly, the last a little more than one-half the length of the penultimate; longest verticils of the intermediate segments subequal in length to the segment itself. Head velvety black; vertical tubercle slightly notched at summit.

Pronotum black. Mesonotal præscutum black, with three pruinose, silvery-gray stripes that are virtually confluent behind, the median one insensibly split by a capillary dark vitta; scutum dull black, the centers of the lobes silvery pruinose; scutellum and postnotum black, more sparsely pruinose. Pleura

[4] Loc. cit.

black. Halteres black. Legs relatively slender, black, the femoral bases somewhat brighter, especially the lower surface of the posterior femora where more than the basal half is involved. Wings (Plate 1, fig. 9) with a strong blackish tinge; stigma indicated by a narrow darker area lying in cell Sc_1 above vein R_2; a pale streak in cell 1st A adjoining the basal half of the vein; veins dark brown. Veins beyond cord with abundant macrotrichia. Venation: Sc_1 ending about opposite the fork of R_{2+3+4}, Sc_2 about opposite the fork of Rs; Rs angulated and sometimes weakly spurred at origin; R_{2+3+4} subequal to R_{1+2} and much shorter than R_{2+3}; cell M_1 subequal in length to its petiole; cell 1st M_2 rectangular, with m-cu at midlength; cell 2d A of moderate width.

Abdomen velvety black, the proximal tergites with narrow, more nacreous, basal rings, the subterminal segments uniformly black; sternites with the basal rings more extensive, obscure brownish yellow, the surface sparsely pruinose. Genital segment fiery orange; valves of ovipositor long and slender, somewhat more yellowish horn color.

Habitat.—Sumatra (Benkoelen).

Holotype, female, Boekit Itam, altitude 1,000 to 2,000 feet, June 11 to 15, 1935 (*Walsh*).

Hexatoma (*Eriocera*) *caninota* is most nearly allied to *H.* (*E.*) *plutonis* sp. nov., differing especially in the silvery thoracic markings and in the venation, as the short R_{2+3+4} and the position of m-cu at near midlength of cell 1st M_2.

HEXATOMA (ERIOCERA) INDECORA sp. nov. Plate 1, fig. 10.

Head and thorax dark gray, the praescutum with four dull black stripes that are narrowly bordered with deeper black, femora brownish yellow, the tips narrowly blackened; wings suffused with rich fulvous-brown, the prearcular and costal areas even brighter, R_{1+2} longer than R_{2+3+4}; cell M_1 present but small and tending to become evanescent; abdominal segments one to four orange-yellow, unmarked except for the dark pleural membrane; outer segments, including hypopygium, black.

Male.—Length, about 14 to 17 millimeters; wing, 11.5 to 16.

Rostrum black, pruinose; palpi black. Antennæ (male) 8-segmented; scape and pedicel black, flagellum yellowish brown to brown, the outer segments darker; flagellar segments cylindrical, gradually decreasing in length outwardly; terminal segment a little longer than the penultimate. Head dark brown,

the anterior vertex and orbits light gray; vertex with numerous long black and yellow setæ; vertical tubercle relatively high, simple.

Pronotum black, pruinose. Mesonotal præscutum dark gray, with four dull black stripes that are narrowly bordered with deeper black, vestiture restricted to the interspaces, long and conspicuous, chiefly pale; scutal lobes dark brown, the median area gray; scutellum dull blackish gray, with abundant long yellow setæ; mediotergite black. Pleura black, sparsely pruinose; mesepisternum with long setæ. Halteres black. Legs with the coxæ and trochanters black, sparsely pruinose; femora brownish yellow to yellowish brown, the bases clearer yellow, the tips rather narrowly (1.5 millimeters) blackened, the amount subequal on all legs; tibiæ and tarsi black. Wings (Plate 1, fig. 10) almost uniformly suffused with rich fulvous-brown, the prearcular and costal regions even brighter; veins pale yellowish brown. Macrotrichia present on veins R_3, R_4, and distal section of R_5, restricted to virtually lacking on outer medial branches. Venation: Sc_1 ending opposite the slightly oblique R_2, Sc_2 about opposite the fork of R_{2+3+4}; R_{1+2} longer than R_{2+3+4}; R_{1+3} a little longer than R_2; cell M_1 usually present but tending to become evanescent, lacking in one paratype specimen; when best developed, shorter than its petiole; m-cu from one-third to one-half its length beyond the fork of M.

Abdomen with segments one to four orange-yellow, unmarked except for a narrow pleural darkening; outer segments, including hypopygium, black; no differentiated basal pattern or polishing on any of the segments.

Habitat.—Sumatra (Benkoelen).

Holotype, male, Tandjong Sakti, altitude 1,650 to 2,000 feet, June 1 to 10, 1935 (*Walsh*). Paratopotypes, 2 males, May 26 to June 10, 1935 (*Walsh*).

By Edwards's key to the species of *Eriocera*[1] the present fly runs to couplet 45, where it disagrees with all species beyond this point. It agrees fairly well with *Hexatoma* (*Eriocera*) *umbripennis* (Edwards) of Penang, but is amply distinct in all details of structure and coloration. The figure of the type of *umbripennis*[2] shows cell M_1 lacking or very evanescent, but in the original definition of the species it is described as being present and a little longer than its petiole.

[1] Loc. cit. [2] Tom. cit. pl. 10, fig. 2.

HEXATOMA (ERIOCERA) MESOPYRRHA (Wiedemann).

Limnobia mesopyrrha WIEDEMANN, Aussereur. zweifl. Ins. 1 (1828) 26.

JAVA, Mount Djampangs, altitude 2,000 feet, September, 1933, April, 1934 (*Walsh*). Wynkoope Bay, April, 1933 (*Walsh*).

HEXATOMA (ERIOCERA) FLAVOHIRTA sp. nov. Plate 1, fig. 11.

Belongs to the *mesopyrrha* group; general coloration black, the præscutum, scutum, and scutellum with conspicuous yellow setæ; halteres and legs black, the femoral bases restrictedly paler; wings dark brown, the broad prearcular region and a band before cord yellow, the latter not reaching the costal border; abdomen velvety black, segments two to four clear orange-yellow with black lateral borders; hypopygium brown; genital segment of female orange.

Male.—Length, about 16 to 17 millimeters; wing, 15 to 15.5.

Female.—Length, about 23 to 24 millimeters; wing, 18 to 18.5.

Rostrum and palpi black. Antennæ with scape and pedicel black; flagellum with basal segment obscure yellow, the succeeding segments passing through brownish yellow to black; antennæ 7-segmented (male); flagellar segments gradually decreasing in length outwardly. In the holotype the second flagellar segment abnormally swollen at base on both antennæ. Head dull black, the surface gray pruinose, leaving areas of the ground color on either side of the posterior vertex; vertical tubercle simple, relatively low; setæ of head black.

Mesonotum opaque black, the præscutal stripes only a little more grayish black than the deep black interspaces, the lateral and humeral portions more grayish; præscutum, scutum, and scutellum with long conspicuous appressed yellow setæ, on the præscutum involving not only the interspaces but the surface of the stripes themselves, only the anterior ends of the intermediate stripes being destitute of them; mediotergite glabrous. Pleura dull black or brownish black, the surface weakly pruinose; yellow setæ on dorsal sternopleurite in male and on both sternopleurite and anepisternum in female. Halteres black. Legs with the coxæ black, pruinose; trochanters black; femora black, the bases narrowly yellowish on foreleg, somewhat more extensively infuscated on middle and hind legs; tibiæ and tarsi black to brownish black. Wings (Plate 1, fig. 11) dark brown, in the male with cell C more reddish brown, cell Sc more yellowish; extreme wing base dark; prearcular region broadly pale

yellow; an incomplete light yellow crossband before cord, relatively narrow but widened in radial field, extending from vein R_1 to the posterior margin of wing on either side of vein Cu_1; veins brown, more yellowish in the brightened areas. Costal fringe greatly reduced (male) to abundant (female), as in the group. Venation: Sc_1 ending opposite the transverse R_2; R_{1+2} a little longer than R_{2+3+4}; cell M_1 present; m-cu at near midlength of cell 1st M_2, longer than the distal section of Cu_1.

Abdomen velvety black, segments two to four clear orange-yellow, the segments narrowly bordered laterally with black; segments without leaden or scoriaceous basal rings; hypopygium brown to brownish black. In the female, the extreme caudal borders of tergites two to four are insensibly darkened; genital segment deep orange; cerci very long and slender, black, with pale tips.

Habitat.—Sumatra (Benkoelen).

Holotype, male, Boekit Itam, altitude 1,000 to 2,000 feet, June 11 to 15, 1935 (*Walsh*). Allotype, female, Moeara Tenam, July 4 to 14, 1935 (*Walsh*). Paratopotype, male. Paratype, female, with the allotype.

By Edwards's key to the Old World species of *Eriocera*[1] the present fly runs to couplet 86, disagreeing widely with both included species, *bicolor* Macquart (*bengalensis* Alexander) and *cingulata* (de Meijere). It is more closely related to *metopyrrha* (Wiedemann), differing in the black coloration, more distinctly yellow wing pattern, and the abdominal coloration. It should be noted that there is a slight error in Edwards's key, where *cingulata* runs to that group of species having black legs (couplet 81). In reality, the species has the femora yellow with the tips rather narrowly but conspicuously blackened.

HEXATOMA (ERIOCERA) MULTICOLOR sp. nov. Plate 1, fig. 11.

Mesonotal præscutum and scutum velvety black, without markings; antennæ with scape and pedicel black, flagellum yellow; scutellum obscure orange, mediotergite yellow; legs with the femora yellow, the tips narrowly black, tibiæ and tarsi darkened; wings brown, the anal cells paler, a triangular whitish discal area; prearcular and costal regions restrictedly yellowish; wing tip narrowly yellow; cell M_1 present; abdominal tergites polished nacreous, with the caudal margins narrowly ringed with velvety black, the outer segments more uniformly polished black; hypopygium yellow.

[1] Tom. cit. 70-78.

Male.—Length, about 14 millimeters; wing, 13.

Rostrum black, sparsely pruinose; palpi black. Antennæ (male) 7-segmented, short; scape black, pruinose; pedicel brownish black, flagellum yellow, the end of the outer segment a little darkened. Head black, more pruinose adjoining the eyes; vertical tubercle bifid at apex.

Mesonotal præscutum and scutum velvety black, without markings, scutellum obscure orange, parascutella black; mediotergite uniformly yellow, the pleurotergite black, vestiture of mesonotum relatively short and sparse but erect. Pleura, including the dorsopleural membrane, black. Halteres short, stem brown, knob blackened. Legs with the coxæ and trochanters brownish black; femora yellow, the tips narrowly blackened, the amount subequal on all legs; tibiæ brown, with black vestiture; tarsi black. Wings (Plate 1, fig. 12) with the ground color brown, the anal cells more grayish brown; prearcular region clear light yellow; costal border, including cells C and Sc to beyond the stigma, more brownish yellow; a triangular or sagittate white area near center of the wing, the point directed basad, the area occupying cells R_1, R, and M; wing tip light yellow, involving cells R_3, R_4, and M_1, veins dark, more luteous in the yellow areas. Costal fringe long and dense, macrotrichia on R_3, most of R_4, and distal section of R_5, scattered trichia on outer ends of outer medial veins. Venation: Rs about one-third longer than R; R_{2+3+4} and R_{2+3} subequal; cell M_1 subequal to its petiole; m-cu at near three-fourths to four-fifths the length of cell 1st M_2.

Abdominal tergites chiefly polished nacreous, glabrous, and more or less opalescent, the caudal margins narrowly ringed with velvety black, becoming narrower and more restricted outwardly, lacking on the subterminal segments which are more uniformly polished black; basal sternites brown, the succeeding segments more yellowish; subterminal sternites four to eight more blackened; hypopygium yellow.

Habitat.—Sumatra (Benkoelen).

Holotype, male, Boekit Jtam, altitude 1,000 to 2,000 feet, June 11 to 15, 1935 (*Walsh*).

By Edwards's key to the Old World species of the subgenus [30] the present fly runs to *Hexatoma* (*Eriocera*) *plumbolutea* (Edwards) of Assam, differing in the nature of the vestiture and in numerous details of coloration of the thorax, wings, and abdomen.

[30] Loc. cit.

None of the numerous species of *Eriocera* subsequently described by Edwards and the writer is more closely allied.

HEXATOMA (ERIOCERA) NOVELLA sp. nov. Plate 1, fig. 12.

Belongs to the *nepalensis* group; general coloration velvety black; antennal flagellum yellow, legs yellow, the tips of the femora and tibiæ narrowly blackened; wings brown, the base light yellow; a broad white crossband before the cord, entirely traversing the wing; outer branches of R with macrotrichia; R_3 oblique; cell M_1 lacking; m-cu close to fork of M_{3+4}; abdomen black, tergites two to five very heavily light gray pruinose, especially segments two and five, segments three and four more dotted with gray; genital shield of female and the male hypopygium black.

Male.—Length, about 12 millimeters; wing, 10.

Female.—Length, about 15 millimeters; wing, 11.

Rostrum brownish black, palpi black. Antennæ of male 8-segmented, of female apparently 10-segmented; scape and pedicel brownish black, pruinose; flagellum yellow, the terminal segment (male) or segments (female) darkened; flagellar segments cylindrical, gradually decreasing in length outwardly. Head brownish black, with long erect setæ.

Thorax velvety black, without a distinct pattern; præscutal interspaces with relatively sparse erect setæ that are shorter than those of the head. Halteres dusky. Legs with the coxæ black; trochanters brown; femora yellow, the tips rather narrowly but conspicuously blackened, the amount subequal on all legs and involving about the distal sixth or seventh; tibiæ and basitarsi brownish yellow, the tips narrowly blackened, remainder of tarsi black. Wings (Plate 1, fig. 13) dark brown, variegated only by conspicuous light yellow coloration at the base, extending to just beyond the arculus, and a complete white crossband before the cord, extending from C before the outer end of Sc_1 to the posterior border at outer end of cell 1st A; bases of anal cells narrowly whitened; veins brown, yellow in the pale areas. Costal fringe dense; macrotrichia on all radial veins beyond cord; outer branches of M with only a few scattered trichia. Venation: Sc_1 ending nearly opposite r-m; Rs subequal to or a little longer than R, in cases weakly angulated at origin; R_3 oblique, at or beyond fork of R_{2+3+4}; tip of R_4 rather strongly upcurved; cell M_1 lacking; m-cu close to fork of M_{3+4}.

Abdomen black, with tergites two to five very heavily light gray pruinose, not at all polished, leaving the extreme caudal borders of the segments black; segments three and four with the ground color interrupted to produce a dotted effect adjoining the setæ; remainder of abdomen, including the hypopygium and genital shield of female, velvety black; ovipositor long and slender, horn-colored.

Habitat.—Sumatra (Benkoelen).

Holotype, male, Tandjong Sakti, altitude 1,650 to 2,000 feet, July 16 to 19, 1935 (*Walsh*). Allotype, female, Moeara Tenam, June 16 to 23, 1935 (*Walsh*).

By Edwards's key to the Old World species of *Eriocera*[11] the present fly runs to *assamensis* (Edwards) of Assam, which still seems to be its closest ally. It differs conspicuously in the small size, coloration of the antennal pedicel, and the complete white crossband of the wing, this involving cells C and Sc, which are darkened in *assamensis*.

HEXATOMA (ERIOCERA) ACROSTACTA (Wiedemann).

Limnobia acrostacta WIEDEMANN, Dipt. exot. 1 (1821) 14.

SUMATRA, Tanggamoes, Lampangs, altitude 1,600 to 2,000 feet, July 22 to August 5, 1935 (*Walsh*).

WEST JAVA, Mount Djampangs, altitude 1,500 to 2,000 feet, June, 1933 (*Walsh*).

The species shows a somewhat unusual range in size (male, length, 20 to 27 millimeters; wing, 13 to 18). In some specimens the middorsal abdominal stripe is less clearly defined than in others, the median darkened portion being paler at the anterior end of the individual segment than on its caudal portion, partially interrupting the stripe.

HEXATOMA (ERIOCERA) MALEVOLENS sp. nov. Plate 1, fig. 14.

Allied to *acrostacta*; thorax deep velvety black, antennæ 8-segmented in both sexes, flagellum of male black, of female yellowish brown to obscure yellow, head pruinose above, femora yellow, the tips narrowly blackened; wings dark brown or brownish black, the anal cells paler; a vague brightening on vein M shortly before level of origin of Rs; extreme wing tip white; m-cu at from one-half to three-fourths the length of cell 1st M_2; abdomen (male) elongate, velvety black, segments two to

[11] Loc. cit.

five, inclusive, yellow, with the caudal margins blackened, not forming a median stripe, genital shield of female dark, heavily pruinose.

Male.—Length, 20 to 23 millimeters; wing, 12 to 15.

Female.—Length, about 18 to 20 millimeters; wing, 12.5 to 14.

Rostrum and palpi black. Antennæ 8-segmented in both sexes, in cases with the terminal segment indistinctly divided; scape and pedicel black, pruinose; flagellum of male black, of female much paler, yellowish brown to obscure yellow. Head black, heavily pruinose.

Thorax deep velvety black, almost destitute of setæ. Halteres black. Legs with the coxæ and trochanters black, femora yellow, the tips rather narrowly but conspicuously blackened, the amount subequal on all legs; tibiæ obscure yellow, the tips very narrowly and vaguely darkened; tarsi black. Wings (Plate 1, fig. 14) strongly suffused with dark brown or black, the anal cells paler, a vague brightening on vein M shortly before the level of origin of Rs, extreme wing tip white, including the outer end of cell R_4 and adjoining portion of cell R_3; veins dark. Venation: Sc_2 in alignment with the slightly oblique R_2, R_{2+3+4} subequal to or a little shorter than the basal section of R_5 and less than one-half R_{1+2}; cell M_1 lacking; m-cu at from one-half to three-fourths the length of cell 1st M_2.

Abdomen of male elongate, as in *acrostacta* and allies; basal segment velvety black, segments two to five yellow, with the caudal margins black, the color continued a short distance cephalad on the individual segments but not forming an uninterrupted or scarcely broken middorsal stripe, as in *acrostacta*; succeeding tergites and hypopygium black; in cases the lateral basal portions of tergite six slightly brightened; segments without differentiated basal rings. In the female, abdomen shorter, the caudal margins of the brightened tergites a little more extensively darkened, but still not forming a continuous stripe; ovipositor with genital shield dark, heavily pruinose.

Habitat.—East Java.

Holotype, male, Nongkodjadjar, Tengger Mountains, altitude 3,600 feet, February, 1936 (*Walsh*). Allotopotype, female, pinned with type. Paratopotypes, 6 of both sexes.

The nearest ally of the present fly is *Hexatoma* (*Eriocera*) *acrostacta* (Wiedemann), which has the abdomen similarly elongated in the male sex, differing in the deep reddish thorax, conspicuous whitened band before cord of wings, and the usually

unbroken middorsal stripe on abdomen. The reduction in the amount of white on the wings makes the present fly somewhat like *H. (E.) albipunctata* (van der Wulp). I am indebted to Doctor de Meijere for an authentic specimen of the latter species, which agrees in all details with van der Wulp's description. This fly has R_2 nearly transverse, subequal to R_{1+2}; cell 1st M_2 subquadrate, with m-cu at midlength; pale apical wing spot restricted to cell R_4; no other pale areas on wing.

HEXATOMA (ERIOCERA) BASILARIS (Wiedemann).

Limnobia basilaris WIEDEMANN, Dipt. exot., 1 (1821) 25.

JAVA, Mount Djampangs, altitude 1,500 to 2,000 feet, July, 1933; February, April, 1934 (*Walsh*).

Radjornandala, Preanger, altitude 1,200 feet, December, 1935 (*Walsh*).

HEXATOMA (ERIOCERA) INTERSTITIALIS sp. nov. Plate 1, fig. 15.

General coloration velvety black; head heavily pruinose; femora yellow, the tips blackened; wings brownish black, the prearcular region black; an incomplete white crossband before cord, together with two small, clearly delimited white marks basad of this band; wing tip pale, bicolorous, the extreme margin yellow, bordered internally by white; veins Sc_2 and R_2 in approximate or actual transverse alignment; cell M_1 lacking; cell 1st M_2 short, with m-cu lying far distad; abdominal segments velvety black, with dark-colored glabrous basal rings; genital shield of ovipositor black, pruinose.

Female.—Length, about 12 to 13 millimeters; wing, 9 to 10.

Rostrum black, sparsely pruinose; palpi black. Antennæ (female) 10-segmented; scape and pedicel black, the former sparsely pruinose; flagellum black or with the basal two segments brownish yellow, the outer segments passing into black; antepenultimate and penultimate segments subequal, the terminal a little longer. Head black, heavily silver-gray pruinose, especially on the front and broad anterior vertex, the color continued onto the posterior vertex as a triangular area; vertical tubercle low.

Thorax deep velvety black, without evident stripes or markings; thorax virtually destitute of setæ. Halteres black. Legs with the coxæ and trochanters black; femora yellow, the tips rather narrowly (1 to 1.2 millimeters) and abruptly blackened, the amount subequal on all legs; tibiæ brown, the tips narrowly more blackened; tarsi black. Wings (Plate 1, fig. 15) with the

ground color brownish black, anal cells somewhat paler, prearcular region dark; cells C and Sc more yellowish brown; a complicated white pattern, including an incomplete narrow crossband before cord, extending from veins R_1 to 1st A, and two small, clearly defined dashes before this band, one crossing cells R and M before the origin of Rs, the other transverse, crossing Rs at near one-third the length; wing tip bicolorous, the extreme margin pale yellow, the remainder white, extending from tip of vein R_{1+2} almost to vein M_{1+2}; veins brown, paler in the white areas. Rather sparse scattered trichia on radial veins beyond cord, lacking in medial field. Venation: Sc_1 ending just beyond R_2, Sc_2 only a short distance from its tip and in alignment with R_2 or virtually so; R_{2+3} very long, approximately twice R_{2+3+4}; R_{3+4} shorter than R_2, subperpendicular; cell M_1 lacking; cell 1st M_2 short, with m-cu lying at or beyond four-fifths the length.

Abdominal tergites velvety black, the basal rings of the segments broadly glabrous, nacreous brown, without yellow tones; genital shield black pruinose; cerci elongate, horn yellow, blackened basally.

Habitat.—Sumatra (Benkoelen).

Holotype, female, Moeara Tenam, June 16 to 23, 1935 (*Walsh*).

Paratopotype, female, July 4 to 14, 1935 (*Walsh*).

The present fly is most nearly allied to *Hexatoma* (*Eriocera*) *basilaris* (Wiedemann) and *H.* (*E.*) *pannosa* (Enderlein), differing in the diagnostic features listed, as the intensely black, nearly glabrous thorax, darkened wing base, and darkened nacreous bases of the abdominal segments. The fact that there are only two basal white areas on the wing disc should be noted.

HEXATOMA (ERIOCERA) ARGYROCEPHALA sp. nov. Plate 1, fig. 15.

General coloration of thorax velvety black; head above silver gray; antennal flagellum pale basally, thorax almost glabrous, knobs of halteres obscure yellow; femora yellow, the tips narrowly blackened, wings dark, the prearcular region light yellow, a narrow white crossband before cord, extending from vein R_1 to 1st A, two small white spots in cells R and M; wing tip narrowly white, R_2 oblique, cell M_1 lacking; abdomen black, segments two to four (male) or two and three (female) yellow, narrowly darkened basally; male hypopygium black, ovipositor with genital shield heavily pruinose above.

Male.—Length, about 14 to 17 millimeters; wing, 9 to 12.

Female.—Length, about 16 to 18 millimeters; wing, 11.

Rostrum and palpi black. Antennæ of male 8-segmented, of female 10-segmented, scape and pedicel black, heavily pruinose; basal one or two flagellar segments obscure yellow, the outer segments passing through light to dark brown, flagellar segments gradually decreasing in length outwardly. Head above silvery gray, including the front, anterior vertex and cephalic portion of posterior vertex, the remainder of head dark brown; vertical tubercle not or scarcely developed; anterior vertex wide.

Thorax uniformly velvet black, almost glabrous. Halteres with stem dark brown, knob obscure yellow, weakly tipped with dusky. Legs with the coxæ velvety black, trochanters light brown; femora yellow, the tips narrowly black, the amount subequal on all legs and including about the distal sixth to eighth of the segment; tibiæ yellow, more obscure beyond base, the tip narrowly blackened; tarsi black. Wings (Plate 1, fig. 16) dark brown, the anal cells paler, especially at base; a handsome pattern of yellow and white; extreme wing base darkened; prearcular region and usually cell Sc yellow, cell C infuscated; an incomplete white crossband before cord, extending from vein R_1 to 1st A, just before the outer end of the latter; two small whitish spots in cells R_1 and M, respectively, the former crossing Rs into cell R; wing tip conspicuously white, involving cells R_3 to R_5, inclusive, veins dark, yellow in the pale areas. Costal fringe dense and abundant in both sexes; outer radial branches with relatively numerous trichia over most of their length, a few scattered trichia on outer section of vein M_{1+2}, other veins beyond cord glabrous. Venation: R_2 oblique, almost in transverse alignment with the unusually erect R_{2+3}; in the paratype female longer and even more oblique, at the fork of R_{2+3+4}, vein R_4 upcurved at tip; cell M_1 lacking; m-cu at near two-thirds to three-fourths the length of cell 1st M_2.

Abdomen with basal segment velvety black, tergites two to four pale yellow, with scarcely differentiated basal rings, these narrowly darkened in some individuals; tergites five and six velvety black, with broad, more polished black basal rings; seventh tergite polished black, hypopygium black; sternites yellow, the incisures weakly darkened. In the female, segments two and three yellow, the remainder velvety black, with narrow glabrous basal rings on tergites four to six; genital shield heavily pruinose above, more reddish on ventral surface, cerci blackened basally, the remainder of the long valves dark horn-colored.

Habitat.—Sumatra (Benkoelen).

Holotype, male, Tandjong Sakti, altitude 1,650 to 2,000 feet, June 1 to 10, 1935 (*Walsh*). Allotype, female, Roekit Itam, altitude 1,000 to 2,000 feet, June 11 to 16, 1935 (*Walsh*). Paratopotypes, 4 males, May 26 to July 19, 1935. Paratypes, 1 female, with the allotype; 1 male, Moeara Tenam, July 4 to 14, 1935 (*Walsh*).

By Edwards's key to the Old World species of the subgenus[17] the present fly runs to *Hexatoma* (*Eriocera*) *javensis* (Doleschall), which differs conspicuously in the pattern of the wings and abdomen. The silvery head of the present insect, while very conspicuous and distinctive, is likewise found in other allied forms.

HEXATOMA (ERIOCERA) VIDUA sp. nov. Plate 1, fig. 17.

Male.—Length, about 13 to 15 millimeters; wing, 8.5 to 10.

Very similar to *H.* (*E.*) *interstitialis* sp. nov., differing in the following regards. Antennæ of male 8-segmented; black throughout; third flagellar segment longer than the second, the others gradually decreasing in length outwardly. Entire vertex heavily light gray pruinose. Wings (Plate 1, fig. 17) with the white markings based of the medial crossband larger but with very diffuse margins, the more basal involving cell M only; a distinct pale area in cell R_3 at near midlength; white apex very restricted, without yellow outer border, involving outer ends of cells R_3 and R_4. A few scattered macrotrichia on outer section of M_{1+2}. Venation: Sc_1 very short, extending only a short distance beyond R_2; m-cu at or shortly before outer end of cell 1st M_2. Abdomen more elongate, this probably a sexual character only; basal segment black; segments two to five, inclusive, bright yellow, with relatively narrow, black, caudal borders; succeeding segments and hypopygium black; no differentiated glabrous basal rings on segments.

Habitat.—Sumatra (Benkoelen).

Holotype, male, Moeara Tenam, June 16 to 23, 1935 (*Walsh*).

Paratopotype, male, July 4 to 14, 1935 (*Walsh*).

HEXATOMA (ERIOCERA) ATRISOMA sp. nov. Plate 1, fig. 18.

Body, together with antennæ, halteres and legs, black; wings strongly suffused with black, the anal cells more grayish; an incomplete white band before cord, together with two small, dirty white spots based of the band; a narrow, nearly terminal

[17] Loc. cit.

white area; outer radial veins with numerous macrotrichia; Sc_2 in alignment with the slightly oblique R_2; R_{1+2} more than twice R_{2+3+4}; m-cu near outer end of cell 1st M_2.

Male.—Length, about 16 millimeters; wing, 12.

Rostrum and palpi black. Antennæ of male 8-segmented, black throughout, terminal segment a little longer than the penultimate. Head velvety black; vertical tubercle low and inconspicuous; a pale spot near center of posterior vertex, this possibly an abnormality of the type specimen, head with sparse black setæ.

Thorax uniformly deep velvety black; præscutal interspaces with sparse erect black setæ. Halteres black. Legs black, the tibiæ and tarsi a little less intensely so than the femora. Wings (Plate 1, fig. 18) strongly suffused with black, the anal cells conspicuously more grayish; a white pattern, arranged as follows: A narrow incomplete crossband before cord, extending from vein R_1 to midwidth of cell Cu; two small, obscure whitish spots basad of this band, one on Rs at near one-third the length, the other on vein M just before one-fourth the length, a white lunule, nearly apical, extending from vein R_3 to M_{1+2}, narrowly bordered outwardly by slightly paler brown, veins pale brown, a trifle lighter colored where traversing the white discal band. Macrotrichia on outer radial veins, more sparse and scattered on M_{1+2}. Venation: Sc_2 in alignment with the slightly oblique R_2; R_{1+2} more than twice R_{2+3+4}; cell M_1 lacking, m-cu near outer end of the short-rectangular cell 1st M_2.

Abdomen velvety black, the basal rings more glabrous but not differentiated in color; hypopygium deep black.

Habitat.—North Java.

Holotype, male, Tjolo, Goenoeng Moeria, altitude 2,100 feet, December 1 to 8, 1935 (*Walsh*).

By Edwards's key to the Old World species of the subgenus [9] the present form runs to couplet 105, where it disagrees conspicuously with both included forms by the intense black coloration of the body and appendages. If the pale lunule at wing tip is interpreted as being subapical, the fly runs to the common *Hexatoma* (*Eriocera*) *basilaris* (Wiedemann), which has the wing base broadly yellow, the white pattern of the wings more extensive and differently distributed, and the femoral bases broadly yellow. From other allied Sumatran species described at this time (*interstitialis, argyrocephala,* and *vidua*), the present

[9] Loc. cit.

fly differs in the uniform black coloration of the body and appendages and in the distinctive wing pattern.

HEXATOMA (ERIOCERA) SELENE (Osten Sacken)

Eriocera selene OSTEN SACKEN, Annali Mus. Civ. Genova 16 (1881) 406–407.

Eriocera selene EDWARDS, Bull. Raffles Mus. 7 (1932) 78–79.

Osten Sacken's type, a unique female, was from Goenoeng Singgalang, Sumatra, collected in July, 1878, by Beccari. Edwards recorded two additional males from Siberut Island, Mentawi Islands, west of Sumatra.

Several males and females from different stations in Benkoelen, southeastern Sumatra. Tandjong Sakti, altitude 1,650 to 2,000 feet, July 19, 1935. Moeara Tenam, June 16 to July 14, 1935 (*Walsh*).

The above specimens may be redefined as follows:

Male.—Length, 15 to 17 millimeters; wing, 13 to 15.6.

Female.—Length, 15 millimeters; wing, 12.

The coloration of the thorax varies in different specimens from reddish orange to deep cherry red. Vestiture of head and praescutum relatively sparse but long and conspicuous. Vertical tubercle simple. Antennæ of male 8-segmented, of female 10-segmented; basal flagellar segments yellow, the terminal two (male) to four (female) darkened.

Legs brownish black, the femoral bases restrictedly yellow; tarsi black. Wings dark brown, with two white areas, one before the cord, extending from vein R_1 nearly to Cu, nearly straight to weakly crescentic in outline; second spot at wing tip, involving the outer ends of cells R_3 and R_4; in all specimens before me this latter area is apical in position. A pale streak in cell 1st A, adjoining the basal half of the vein. As stated by Edwards, Rs is unusually short, not exceeding twice the length of R_{2+3+4}, and only a little longer than R_{1+2}; Sc_1 ends before, opposite, or even shortly beyond the transverse R_2; m-cu at from one-third to one-fourth its length before the fork of M_{3+4}. One specimen shows an abnormal venation in having an adventitious crossvein in cell R_3 of one wing and with m obliterated or nearly so by the shortening and approximation of veins M_{1+2} and M_3, the point of union being surrounded by a pale spot.

Abdomen polished black, the caudal margins of the tergites very narrowly velvet black, the amount of the latter decreasing on the outer segments, tergites one, seven, and eight entirely

black. Sternites beyond the basal two velvety black, with narrow glabrous basal rings; hypopygium and genital shield of female black. Osten Sacken's unique type had the latter area reddish.

HEXATOMA (ERIOCERA) SEMILUNATA sp. nov. Plate 1, fig. 19.

General coloration black, antennæ (male) 8-segmented, legs dark brown, the terminal tarsal segments blackened; wings with a strong brown suffusion; prearcular field broadly light yellow, a narrow whitish crossband before cord; wing tip narrowly paler brown than the ground, bordered internally by a very narrow whitish lunule; relatively numerous macrotrichia on outer radial veins, Sc_2 some distance before tip of Sc_1 and before inner end of the oblique R_2, abdomen black, the basal rings broadly glabrous and slightly nacreous.

Male.—Length, about 14 millimeters, wing, 12.5.

Rostrum and palpi black Antennæ of male 8-segmented; scape black, pruinose, remainder of organ black terminal segment longer than the penultimate Head black, silvery pruinose, especially on front and anterior vertex, the color extended into a triangular point behind; vertical tubercle scarcely developed; setæ black, conspicuous.

Thorax velvety black, almost glabrous. Halteres black. Legs with the coxæ and trochanters black; remainder of legs dark brown, the terminal tarsal segments blackened. Wings (Plate 1, fig. 19) with a strong brown suffusion, prearcular field broadly light yellow but the extreme base darkened, a narrow, parallel-sided whitish crossband before cord, extending from vein R almost to 1st A; wing tip narrowly paler brown than the ground, with an extremely narrow, internal, whitish lunule, veins pale brown, lighter colored in the pale areas. Relatively numerous macrotrichia on outer radial veins, these fewer and more scattered on the outer medial branches. Venation: Sc_2 some distance before tip of Sc_1 and before the inner end of the oblique R_2, R_{1+2} nearly twice R_{2+3+4}; m-cu near outer end of cell 1st M_2.

Abdomen black, the basal rings very broadly polished to weakly nacreous, on tergites two and three the apical ring subequal in width to the basal; on outer segments, the velvety apices of the tergites becoming progressively narrower, greatly narrowed on the seventh segment, basal rings of more proximal segments glabrous, segments six and seven with numerous scattered setæ; hypopygium black.

Habitat.—East Java.

Holotype, male, Djoenggo, Mount Ardjano, altitude 4,500 feet, January, 1936 (*Walsh*).

In its general appearance, the present fly somewhat resembles *Hexatoma* (*Eriocera*) *malangensis* Alexander and *H.* (*E.*) *selakensis* (Edwards), differing especially in the nearly apical white lunule of the wings. Both of the species mentioned have the trichia of the wing veins much more restricted and scattered, being actually or nearly lacking on vein R_3 and on the outer medial branches.

HEXATOMA (ERIOCERA) ATRICORNIS Alexander.

Hexatoma (*Eriocera*) *atricornis* ALEXANDER, Philip. Journ. Sci. 54 (1934) 457–458.

One female, Soekaboemi, West Java, altitude 1,800 feet, February 1934 (*Walsh*).

HEXATOMA (ERIOCERA) TOXOPEI sp. nov. Plate 1, fig. 20.

General coloration black; legs brownish black, the femoral bases obscure yellow; wings brownish black, the base conspicuously light yellow; a relatively narrow white crossband before cord; scattered trichia on outer ends of veins R_4, R_5, and M_{1+2}; Rs about four times the basal section of R_5; cell 1st M_2 relatively small, vein M_{1+2} being more than twice the length of the cell; m-cu at midlength of cell 1st M_2; abdominal tergites black, glabrous on basal portions.

Male.—Length, about 14 millimeters; wing, 11.5.

Rostrum and palpi black. Antennæ of male 8-segmented; scape and pedicel brownish black; flagellum brown. Front and anterior vertex heavily pruinose; posterior portion of head black, with relatively conspicuous black setæ.

Thorax black, nearly glabrous. Halteres black. Legs with the coxæ and trochanters black; femora black, the bases broadly obscure yellow, including about the basal third on forelegs and nearly the outer half on the posterior pair, the yellow gradually passing into the dark color; tibiæ and tarsi brownish black. Wings (Plate 1, fig. 20) brownish black, the base conspicuously light yellow to the level of the arculus; a relatively narrow white crossband before cord, extending from vein R_1 across cells R_1, R, and M, barely invading cell Cu behind, veins dark brown, paler in the brightened areas. Trichia present on veins R_4, R_5, and M_{1+2}, scattered and restricted to the outer ends of veins, veins R_3, M_3, and M_4 without trichia. Venation: Sc,

ending just beyond R_2, Sc_2 a short distance from its tip; R_2 only moderately oblique; R_{2+3+4} about one-half R_{1+2}; Rs about four times the basal section of R_5; cell 1st M_2 relatively small, the veins beyond it long, M_{1+2} being more than twice the length of the cell; m-cu at near midlength of cell 1st M_2.

Abdomen, including hypopygium, black, the bases of all but the eighth tergite glabrous but not at all pruinose or whitened, the amount of glabrosity greatest on the more basal segments, becoming less on the outer segments, reaching a minimum on segments seven and eight.

Habitat.—Central Java.

Holotype, male, Goenoeng Soembing, near Kledong, altitude 5,850 feet, May 21, 1933 (*Toxopeus*); through Mrs. M. E. Walsh.

I am pleased to name this species in honor of the collector, Mr. L. J. Toxopeus. In its general appearance and wing pattern, the fly is somewhat similar to *Hexatoma (Eriocera) malangensis* Alexander and *H. (E.) salakensis* (Edwards), both of Java, especially to the former. This has the pattern of the legs and wings distinct and the venational details quite different, as the even more oblique R_2, relatively short Rs, which is not more than three times the basal section of R_5, and the different arrangement of veins in the outer medial field. *Hexatoma salakensis* has the abdomen chiefly yellow and the venational details very distinct, having R_2 exceedingly oblique and Rs unusually short, less than two times the length of the basal section of R_5, in this respect being exceeded only by *H. (E.) selene* (Osten Sacken) among the local species. The wing venation of the present fly is much as in *H. (E.) diengensis* Alexander, but the coloration of the body, especially of the abdomen, is different. It seems probable that *diengensis* will prove to be the closest ally of the present fly.

HEXATOMA (ERIOCERA) CINGULATA (de Meijere).

Eriocera cingulata DE MEIJERE, Tijd. voor Ent. 54 (1911) 58–59.
Eriocera fasciata DE MEIJERE, Tijd. voor Ent. 54 (1911) 59 (name preoccupied by Guérin and Williston).

SOUTH SUMATRA, Boekit Itam, Benkoelen, altitude 1,000 to 2,000 feet, June 11 to 15, 1935 (*Walsh*). Moeara Tenam, Benkoelen, June 16 to 23, 1935 (*Walsh*).

WEST JAVA, Goenoeng Malang, Djampangs, altitude 3,000 feet, July 10, 1933 (*Walsh*). Soekaboemi, altitude 1,800 feet, April 15, 1933 (*Walsh*).

HEXATOMA (ERIOCERA) CONSTRICTA Alexander.

Hexatoma (Eriocera) bengalensis constricta ALEXANDER, Philip. Journ. Sci. 54 (1934) 459–460.

Further material and the study of rather numerous specimens have convinced me that the East Indian species commonly identified as being *Hexatoma (Eriocera) bicolor* (Macquart) cannot be the same as the last-named species, the type specimen of which was from Bengal. The synonymy of *bicolor* (*bengalensis*) is given in the paper cited above, and I consider that this species as now restricted is known only from British India.

The second species, widely distributed in Sumatra, Java, and Borneo, may be considered to be a variety of *constricta* Alexander, the typical form of which I have seen only from West Java. To the more widespread form of the species, having the costal border of the wings broadly yellow, connecting the yellow discal fascia with the prearcular area, I give the name *Hexatoma constricta sunda* subsp. nov.

HEXATOMA CONSTRICTA SUNDA subsp. nov.

Holotype, male, Moeara Tenam, Benkoelen, Sumatra, June 16 to 23, 1935 (*Walsh*). Allotype, female, Tandjong Sakti, Benkoelen, Sumatra, altitude 1,650 to 2,000 feet, July 16 to 19, 1935 (*Walsh*). Paratypes, female, Harau Kloof, West Sumatra, altitude 1,790 feet, June, 1926 (*Jacobson*); male, Borneo, 1891 (*Chaper*).

HEXATOMA (ERIOCERA) LUNIGERA (Walker).

Pterocosmus lunigera WALKER, Proc. Linn. Soc. London 1 (1857) 107.

WEST JAVA, Djampangs, Tengah, altitude 1,600 to 2,000 feet, March, June, 1933 (*Walsh*). Selabintanah, Mount Gedeh, altitude 3,000 feet, December, 1932 (*Walsh*).

HEXATOMA (ERIOCERA) SUBLUNIGERA sp. nov. Plate 1, fig. 3.

Allied to *lunigera*, coloration deep velvety black, the praescutum with three highly polished black stripes; legs and halteres black, the femoral bases more brightened, especially the fore pair; wings dark brown with a narrow broken whitish band before cord and a tiny yellow spot at extreme outer end of cell R_4; abdomen, including genital shield of female, intense black.

Male.—Length, about 13 millimeters; wing 10.

Female.—Length, about 18 millimeters; wing, 13.

Rostrum and palpi black. Antennæ 8-segmented in both sexes; scape black; pedicel brownish black; flagellum dark

brown; terminal segment longer than the penultimate. Head deep velvety black, the anterior vertex very vaguely pruinose; vertical tubercle low and inconspicuous; setæ of head black, sparse but conspicuous.

Pronotum velvety black. Mesonotal præscutum velvety black, with three highly polished black stripes; setæ of interspaces black, sparse and erect; posterior sclerites of mesonotum velvety black. Pleura velvety black, almost glabrous. Halteres black. Legs black, the bases of the fore femora obscure yellow, involving about the proximal third, the bases of the middle and hind femora dark brown. Wings (Plate I, fig. 21) almost uniformly dark brown, the anal cells more grayish, except at apex of cell 1st A and along vein 2d A; a very restricted broken dirty-white band before cord, occurring in outer ends of cells R and M just before fork of M and as an isolated spot in cell R_1, immediately beneath Sc_2; extreme wing tip in apex of cell R_4 very restrictedly yellow; veins dark brown. In the female an additional pale spot near center of cell M_4. Abundant macrotrichia on all outer radial veins, more scattered on distal sections of outer medial veins; vein 1st A with scattered trichia for almost its entire length; veins Cu and 2d A glabrous. Venation: Sc_1 ending opposite or just beyond the fork of R_{2+3+4}, far before R_2; R_{1+2} shorter than R_{2+3+4}; cell 1st M_2 approximately as long as the longest veins issuing from it, with m-cu at or beyond three-fourths the length of the cell.

Abdomen deep velvety black, the segments with the basal rings more glabrous but only feebly differentiated from the remainder, concolorous; hypopygium black. Genital segment of female deep velvety black; cerci black at bases, the outer ends passing into brown.

Habitat.—East Java.

Holotype, male, Nongkodjadjar, Tengger Mountains, altitude 3,600 feet, February, 1936 (*Walsh*). Allotopotype, female.

The nearest ally of the present fly is *Hexatoma* (*Eriocera*) *lunigera* (Walker), which has similar highly polished præscutal stripes. The species here described is readily told by the restricted broken white band before the cord of wing, and the reduction of the yellow apical lunule to a tiny brightening at extreme outer end of cell R_4. The black, instead of orange, genital shield of the female, is very conspicuous. In addition, the præscutal stripes of this fly are black instead of blue-black, as is the case in *lunigera*.

ERIOPTERINI

TRENTEPOHLIA (PLESIOMONGOMA) SUBCANDIDIPES sp. nov. Plate 1, fig. 22.

Allied to *candidipes*, size large (wing, male, 9 millimeters); mesonotal præscutum and the pleura uniformly orange-yellow, unmarked; femora yellow, passing into dark brown towards outer ends, the tips abruptly white; tibiæ and tarsi white; wings relatively narrow, subhyaline, the tip narrowly but distinctly infumed; cord and vein R_s very narrowly seamed with dusky; abdomen yellow, the tergite with an entire black median stripe, the outer two segments entirely black.

Male.—Length, about 12 millimeters; wing, 9.

Rostrum dark brown; palpi brownish black. Antennæ pale brown, relatively elongate, if bent backward ending a short distance before the wing root; flagellar segments cylindrical, with the incisures poorly evident; verticils shorter than the segments. Head light gray, the posterior vertex darker on either side of the median line; anterior vertex narrow, carinate.

Cervical sclerites brownish black. Pronotum and mesonotal præscutum entirely orange-yellow, unmarked; scutal lobes darkened, the remainder of scutum pale; scutellum and postnotum chiefly darkened. Pleura and pleurotergite uniformly orange-yellow. Halteres black, the base of stem restrictedly pale yellow. Legs elongate; coxæ and trochanters yellow; femora yellow basally, passing into dark brown on the outer fourth or fifth, the tips abruptly and rather broadly (2 millimeters) snowy white, the amount subequal on all legs; tibiæ and tarsi white, the fore and middle tarsi slightly more darkened on subbasal portion to produce a dirty white appearance; all femora with scattered erect setæ distributed throughout their length. Wings (Plate 1, fig. 22) relatively narrow, subhyaline; prearcular region and cells C and Sc very slightly more yellowish; stigma small, triangular, dark brown; wing tip narrowly and weakly infumed; origin of Rs, R_2, cord, and vein R_3 very narrowly seamed with dusky; veins black, paler in the brightened costal portion. Venation: Rs subequal to R_{1+3+4}.

Abdomen elongate; tergites yellow, with a relatively broad, continuous, black, median stripe; sternites uniformly yellow, eighth and ninth segments uniformly black.

Habitat.—North Java.

Holotype, male, Tjolo, Goenoeng Moeria, altitude 2,100 feet, December 8, 1935 (*Walsh*).

The only allied described species is *Trentepohlia* (*Plesiomongoma*) *candidipes* Edwards (Malay Peninsula: Selangor), which differs especially in the small size, heavily patterned mesonotal præscutum, undarkened wing tip, and distinct abdominal coloration.

Genus GONOMYIA Meigen

Gonomyia MEIGEN, Syst. Beschr. zweifl. Ins. 1 (1818) 146.

Considerable confusion has arisen in the subgeneric classification of certain of the more generalized species of the vast genus *Gonomyia*. Until recently, all such groups had been placed in *Progonomyia* Alexander, but it now seems advisable to recognize three subgeneric groups within this particular complex of forms. These subgenera may be separated as follows:

1. Vein R_2 preserved .... *Progonomyia* Alexander.
   Vein R_2 atrophied .... 2.
2. Ovipositor with elongate sclerotized valves.......... *Ellipteroides* Becker
   Ovipositor with short fleshy valves .... *Protogonomyia* Alexander

Subgenus PROGONOMYIA Alexander

Gonomyella ALEXANDER, Ann. South African Mus. 17 (1917) 152, preoccupied.

Progonomyia ALEXANDER, Cornell Univ. Mem. 38 (1920) 938, renaming of last.

Type of subgenus: *Gonomyia* (*Progonomyia*) *slossonæ* Alexander (southern Nearctic; Neotropical).

There are more than a score of described species in the Neotropics, together with the following species restricted to South Africa: *Gonomyia* (*Progonomyia*) *brevifurca* Alexander, *G.* (*P.*) *flaveola* Alexander; *G.* (*P.*) *natalensis* Alexander; *G.* (*P.*) *nigrobimbo* Alexander, *G.* (*P.*) *pulchrissima* Alexander.

Subgenus ELLIPTEROIDES Becker

Ellipteroides BECKER, Zeitschr. für. Syst. Hym. und Dipt. 7 (1907) 239.

Type of subgenus: *Gonomyia* (*Ellipteroides*) *picea* (Becker) (southern Palearctic: Tunis).

All included species are Palæarctic and Oriental in distribution. Besides the subgenotype, the following are included.

Western Palæarctic: *Gonomyia* (*Ellipteroides*) *alboscutellata* (Röser), synonyms *limbata* Röser, *scutellata* Egger; *G.* (*E.*) *lateralis* (Macquart), synonyms *cincta* Egger, *manifesta* Walker. It seems somewhat questionable to me whether *picea* can be

maintained as distinct from *lateralis*. On the other hand, the often overlooked *G.* (*E.*) *atra* Huguenin [14] appears to be distinct from *albosculellata*.

Oriental. *Gonomyia* (*Ellipteroides*) *atropolita* sp. nov.; *G.* (*E.*) *tenebrosa* Edwards, *G.* (*E.*) *terebrella* Alexander.

Gonomyia (*E.*) *brunnescens* Edwards (Borneo), still known only from the male sex, probably belongs here but may fall in the subgenus *Protogonomyia*.

Subgenus PROTOGONOMYIA Alexander

Protogonomyia ALEXANDER, Philip. Journ. Sci. 55 (1934) 52-53.

Type of subgenus: *Gonomyia* (*Protogonomyia*) *confluenta* Alexander (Oriental: Formosa).

All included species are eastern Palæarctic and Oriental. Besides the subgenotype, these are: *Gonomyia* (*Protogonomyia*) *clitellata* Alexander; *G.* (*P.*) *lenis* sp. nov., *G.* (*P.*) *nigripes* (Brunetti), synonyms *gracilis* Brunetti, *incompleta* Brunetti, *nigra* Brunetti; *G.* (*P.*) *perturbata* Alexander, *G.* (*P.*) *scutellum-album* Alexander.

GONOMYIA (ELLIPTEROIDES) ATROPOLITA sp. nov. Plate 1, fig. 11.

General coloration black, the three præscutal stripes and centers of scutal lobes intensely polished, the remainder of thorax chiefly with a sparse pruinosity; scutellum with posterior border narrowly brownish yellow; head brown, the center of vertex brownish black; halteres blackened; femora brownish yellow, the apex on outer face narrowly blackened; wings subhyaline; stigma long-oval, darker brown; veins dark brown, heavy and conspicuous.

Female.—Length, about 6 millimeters; wing, 6.5.

Rostrum and palpi black. Antennæ with scape and pedicel yellow, flagellum black; flagellar segments oval, with verticils that exceed the segments in length. Head brown, the center of vertex brownish black, the surface dull.

Pronotum black laterally, obscure yellow medially; anterior lateral pretergites yellow. Mesonotal præscutum intense black, the three usual stripes polished, the interspaces sparsely and vaguely pruinose; humeral region of præscutum very restrictedly brightened; scutum black, the centers of the lobes more polished, the median area more pruinose; scutellum blackened, the posterior margin narrowly and obscurely brownish yellow, the surface sparsely pruinose; mediotergite black, the surface with

[14] Dipt. Helvetiæ (1880) 50, couplet 4.

a sparse pruinosity. Pleura dull black, vaguely marked with paler on the pteropleurite; dorsopleural membrane light yellow. Halteres blackened. Legs with the coxæ brown, more darkened basally; trochanters obscure yellow; femora brownish yellow, the apex on outer face restrictedly darkened; tibiæ and tarsi yellowish brown to brown, the outer tarsal segments passing into brownish black; legs conspicuously hairy. Wings (Plate 1, fig. 23) subhyaline or with a barely indicated brownish tinge; stigma distinct, long-oval, darker brown; a scarcely evident darkening on anterior cord; veins dark brown, heavy and conspicuous. Venation: Sc_1 ending about opposite two-thirds the length of Rs, Sc_2 at near one-fifth this length; cell R_2 relatively wide at margin, subequal to R_3; cell 2d M_2 slightly exceeding twice its petiole; m-cu at fork of M.

Abdomen black, the surface weakly pruinose; cerci elongate, horn-yellow.

Habitat.—West Java.

Holotype, female, Tjiböröm, altitude 4,000 feet, September 20, 1935 (*Walsh*).

The nearest ally of the present fly is *Gonomyia* (*Ellipteroides*) *tenebrosa* Edwards, of peninsular Siam, which has the legs dark brown, the wings brownish tinged and without a stigmal darkening. In the present fly vein R_{2+3+4} is less than one-half R_3 and m-cu is at the exact fork of M.

GONOMYIA (PROTOGONOMYIA) LENIS sp. nov. Plate 1, fig. 24.

Size small (wing, female, 5 millimeters); general coloration of mesonotum brown, without clearly defined darker markings; legs, including tarsi, pale brown; wings very slightly tinged with brown, the prearcular and costal portions a little more yellowish; Sc long, Sc_1 ending shortly before the fork of Rs; anterior branch of Rs lying close to vein R_{1+2}, cell R_3 narrow at margin; abdominal tergites dark brown, the sternites obscure yellow.

Female.—Length, about 5 millimeters; wing, 5.

Rostrum yellow; palpi long and conspicuous, brownish black. Antennæ with scape and pedicel yellow, flagellum black; organ relatively long, if bent backward nearly attaining the wing root; flagellar segments long-oval, the verticils about as long as the segments. Head dark brown.

Cervical region brown, relatively long. Pronotum pale medially, more blackened on sides. Mesonotal præscutum brown, without clearly defined darker markings; scutellum obscure yel-

low. Pleura infuscated on dorsal portions, more yellowish ventrally. Halteres dark brown, the basal portion of stem obscure yellow. Legs with the coxæ and trochanters yellow; remainder of legs pale brown, including all tarsal segments. Wings (Plate 1, fig. 24) with a very slight brown tinge, the prearcular and costal portions a little more yellowish; veins delicate, pale brown, more yellowish in the costal and basal portions. Venation: Sc long, Sc_1 ending shortly before fork of Rs, Sc_2 far from its tip, just before one-third the length of Rs, anterior branch of Rs lying close to R_{1+2}, cell R_2 at margin narrow; cell 2d M_2 deep, its petiole subequal to m-cu, the latter at or just before fork of M.

Abdominal tergites dark brown, sternites and pleural membrane obscure yellow. Ovipositor with very short fleshy valves, as in the subgenus; hypovalvæ obtusely rounded at tips.

Habitat.—West Java.

Holotype, female, Bodjang Kalang, Djampangs, September, 1935 (*Walsh*).

The most similar species is *Gonomyia* (*Protogonomyia*) *clitellata* Alexander, of Formosa, which differs in all details of coloration and venation, as the short Sc, nearly straight unbowed Rs, and the short cell 2d M_2. The present fly differs from all described members of the subgenus in the more-arched anterior branch of Rs, which thus lies unusually close to vein R_{1+2}, so that cell R_2 at margin is unusually narrow.

ILLUSTRATIONS

Plate 1 Venation

Fig. 1. *Dolichopeza* (*Nesopeza*) *dira* sp. nov.
2. *Scamboneura sumatrensis* sp. nov.
3. *Limonia* (*Libnotes*) *luteithorax* sp. nov.
4. *Limonia* (*Libnotes*) *clauda* sp. nov.
5. *Limonia* (*Pseudoglochina*) *querula* sp. nov.
6. *Pseudolimnophila nycteris* sp. nov.
7. *Hexatoma* (*Eriocera*) *subaurantia* sp. nov.
8. *Hexatoma* (*Eriocera*) *plutonis* sp. nov.
9. *Hexatoma* (*Eriocera*) *cauticola* sp. nov.
10. *Hexatoma* (*Eriocera*) *indecora* sp. nov.
11. *Hexatoma* (*Eriocera*) *flavohirta* sp. nov.
12. *Hexatoma* (*Eriocera*) *multicolor* sp. nov.
13. *Hexatoma* (*Eriocera*) *novella* sp. nov.
14. *Hexatoma* (*Eriocera*) *macevolens* sp. nov.
15. *Hexatoma* (*Eriocera*) *interalbitialis* sp. nov.
16. *Hexatoma* (*Eriocera*) *argyrocephala* sp. nov.
17. *Hexatoma* (*Eriocera*) *vidua* sp. nov.
18. *Hexatoma* (*Eriocera*) *atricoma* sp. nov.
19. *Hexatoma* (*Eriocera*) *semilunata* sp. nov.
20. *Hexatoma* (*Eriocera*) *toxopei* sp. nov.
21. *Hexatoma* (*Eriocera*) *sulphurigera* sp. nov.
22. *Trentepohlia* (*Plesiomongoma*) *subcandidipes* sp. nov.
23. *Gonomyia* (*Ellipteroides*) *atropolita* sp. nov.
24. *Gonomyia* (*Protogonomyia*) *lenis* sp. nov.

PLATE I.

DIPLOSENTIS AMPHACANTHI GEN. ET SP. NOV., AN ACANTHOCEPHALA PARASITIC IN A MARINE FISH

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Of the Bureau of Science, Manila

ONE PLATE AND TWO TEXT FIGURES

DIPLOSENTIS AMPHACANTHI gen. et sp. nov.

Numerous specimens of this interesting proboscis roundworm were found in the intestine of a fish, *Amphacanthus oramin*, caught in Mucilagos Bay, northern Mindanao. We wish to thank Dr. Hilario A. Roxas, chief of the Fish and Game Administration of the Bureau of Science, for kindly placing the material at our disposal.

The parasite has two morphological features that separate it from all previously recorded Acanthocephala; namely, (*a*) coiled lemnisci inclosed in a membranous sac and (*b*) two elongated tubular prostatic glands. According to the available literature, only *Gleaveus circumspinifer* Subrahmanian, 1927, approaches the Philippine parasite in the possession of much coiled lemnisci, but it differs from the latter in the presence of cuticular spines on its anterior body region and in the number and shape of its prostatic glands. With regard to the latter structures, only *Acanthogyrus acanthogyrus* Thapar, 1927, has previously been reported as possessing two cement glands, all other known acanthocephalans, according to Southwell and Macfie (1925), having either a syncytial mass or at least three prostatic glands. The Philippine species, however, may be distinguished from *A. acanthogyrus* by the form of its lemnisci, its unarmed cuticle, the shape of its proboscis and the number and shape of the proboscis hooks. For these reasons it has been found necessary to propose for it a new genus.

Generic diagnosis.—Cuticle unarmed. Proboscis club-shaped, with simple hooks. Proboscis sheath double-walled, with brain and retinacula in front of middle of its length. Lemnisci much coiled, inclosed in a membranous sac. Male genital organs in posterior two-thirds or three-fourths of body length. Cement

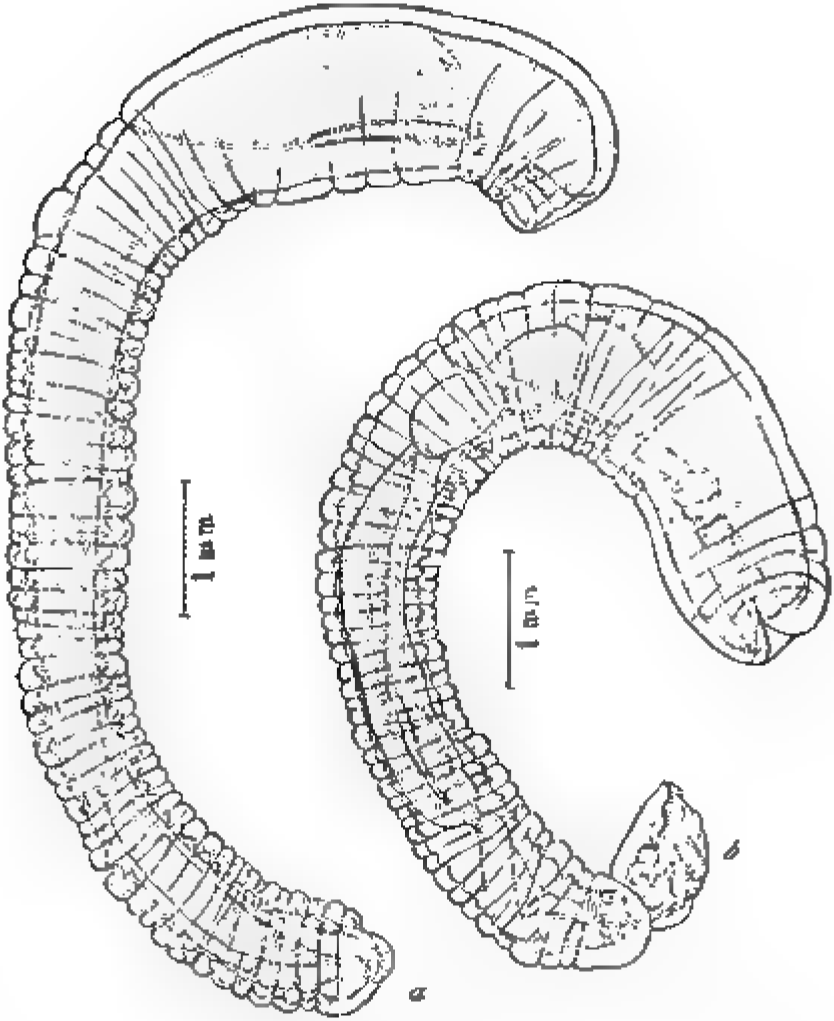

FIG. 1. *Diplosentis amphacanthi* gen. et sp. nov. a, adult female, lateral view; b, adult male, lateral view.

glands two, elongate and tubular. Eggs with three membranes, the middle one with polar prolongations. Parasitic in fishes.

Type species.—*Diplosentis amphacanthi* sp. nov.

Description of type species.—Body devoid of spines, slightly swollen anteriorly and presenting pseudoannulation due to folding of cuticle. Body wall 95 to 135 microns in maximum thickness. Male smaller than female, 3 to 7 millimeters in length by

0.70 to 1.15 millimeters in maximum dorsoventral diameter. Female measures 10 to 18 by 0.85 to 1.20 millimeters.

Proboscis club-shaped, measuring, when fully extended, 0.42 to 0.46 millimeter in length by 0.12 to 0.17 millimeter in maximum diameter. It is armed with 12 longitudinal rows of hooks, each row with 8 to 9 hooks, measuring, except those of the last row, 38.5 to 42 microns in length; hooks of posterior row 19 to 26.5 microns long.

Neck absent.

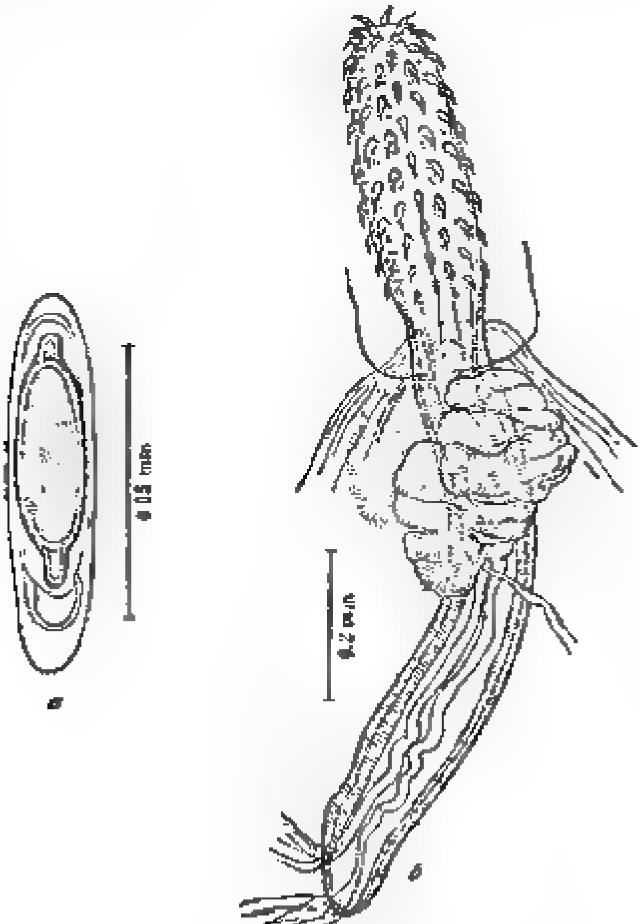

FIG. 2. *Diplosentis amphacanthi* gen. et sp. nov. *a*, egg; *b*, proboscis, proboscis sheath, and lemnisci, enlarged.

Proboscis sheath double-walled, 0.65 to 1.2 millimeters by 0.11 to 0.23 millimeter in size. Nerve ganglion and retinacula immediately in front of middle of length of proboscis sheath.

Lemnisci in the form of a pair of coiled masses, extending posteriorly to near middle of length of proboscis sheath; each mass appears inclosed in a membranous sac.

Testes subglobular to oval, one in front of the other and usually touching, situated in front of middle of body length. Anterior testis slightly larger than posterior testis, the former measuring 0.45 to 0.60 by 0.20 to 0.28, and the latter 0.38 to 0.52 by 0.19 to 0.28 millimeter.

Prostatic or cement glands two, tubular, 1.3 to 3.0 millimeters in length (Plate 1). Cement reservoir 0.5 to 1.3 by 0.14 to 0.36 millimeters in size. Bursa well developed.

Eggs numerous, free in body cavity of gravid females, measuring 61.8 to 78.7 by 16.3 to 18.0 microns. They possess three membranes, the middle one of which is the thickest and has two polar prolongations.

Chief longitudinal vessels of subcuticula lateral.

Host.—*Amphacanthus oramin* Bloch and Schneider.

Location.—Intestine.

Locality.—Mucolagos Bay, Mindanao.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 504.

SYSTEMATIC POSITION

The place of *Diplosentis amphacanthi* in the major classification of the Acanthocephala is undoubtedly in the order Palæacanthocephala Meyer 1931, as emended by Van Cleave (1936), due to the lateral position of the main longitudinal vessels in its subcuticula, the limited number of prostatic glands, the absence of giant subcuticular nuclei and protonephridial organs, and the quincunxial arrangement of the proboscis hooks. It does not fit, however, in any of the families included in that order, for which reason the new family Diplosentidæ, with the characters of the genus *Diplosentis*, as given above, is hereby proposed for it.

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ILLUSTRATIONS

PLATE 1

Diplosentis amphacanthi gen. et sp. nov. Cross section through posterior end of male showing the two prostatic glands.

TEXT FIGURES

FIG. 1. *Diplosentis amphacanthi* gen. et sp. nov.; *a*, adult female, lateral view, *b*, adult male, lateral view.

2. *Diplosentis amphacanthi* gen. et sp. nov.; *a*, egg, *b*, proboscis, proboscis sheath, and lemnisci, enlarged.

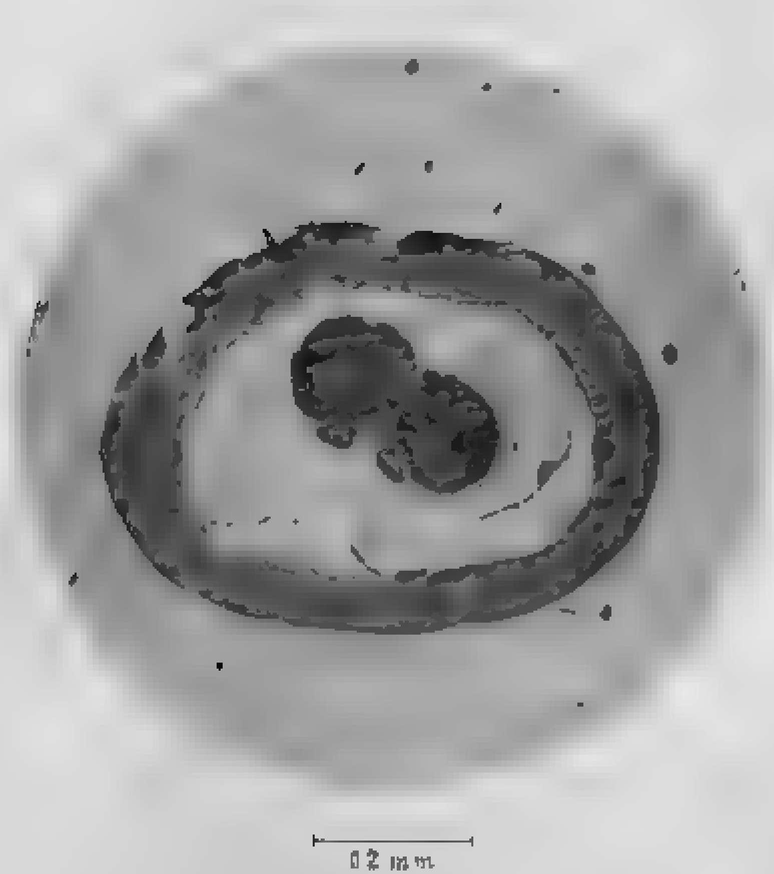


PLATE 1.

DIATOMS FROM IKEDA LAKE, SATSUMA PROVINCE KIUSIU ISLAND, NIPPON

By B. W. Skvortzow

Of Harbin, Manchoukuo

FOUR PLATES

So far as I know, no account of fresh-water diatoms of Ikeda Lake, Nippon, has been published, and the present note thus affords the first available data on this subject. In 1928 I received from Prof. Dr. T. Kawamura, director of the Zoological Institute, College of Science, Kyoto Imperial University, a diatom sample from Ikeda Lake, Satsuma Province, Kiusiu Island, from the southern part of Nippon, collected by Dr. T. Kawamura in January, 1923. According to Dr. M. Ueno, Ikeda Lake is near the town of Kagoshima, 31° 94′ north latitude, at an altitude of 66 feet, with an area of 10.98 square kilometers and a maximum depth of 233 meters. The plankton of this lake is very scarce. The diatom flora of Ikeda is quite rich and 157 forms are here enumerated. I have some reason for believing that future researches may considerably increase the number of species known to live in Ikeda Lake. Several forms, of frequent occurrence in Aokiko, Kizaki, and Biwa Lakes, are also common in Ikeda samples. The diatoms from Ikeda are fresh-water forms. The following species, characteristic of brackish water, were also found: *Mastogloia elliptica* var. *danseí*, *Navicula halophila* var., *Rhopalodia gibberula* var. *Van Heurcki*, *Nitzschia tryblionella* var. *debilis* and var. *Victoriæ*, *N. Clausii*, and *N. frustulum* var. *perpusilla*. Almost all the new species and varieties of diatoms found in Ikeda Lake are named in honor of the late K. Okamura, of Tokyo, the great Nipponese algologist, who died August 21, 1935.

MELOSIRA ITALICA (Ehr.) Kütz. var. VALIDA Grun.

Melosira italica (Ehr.) Kütz. var. *valida* Grun., Fr. Hustedt, Bacillar. (1930) 91, fig. 51.

A diatom with robust frustules, ornamented with coarse puncta and end spines. Rare. Known from Aokiko and Kizaki Lakes.

MELOSIRA ISLANDICA O. Müll. subsp. HELVETICA O. Müll. Plate 1, fig. 12.

Melosira islandica O. Müll. subsp. *helvetica* O. Müll., FR. HUSTEDT, Bacillar. (1930) 89, fig. 48.

Frustule 0.006 to 0.008 mm in breadth, with parallel rows of puncta. Rows of puncta 18, puncta 15 in 0.01 mm. The frustules of Nipponese specimens are similar to those of the European. New to Nippon.

MELOSIRA AMBIGUA (Grun.) O. Müll. status γ.

Melosira ambigua (Grun.) O. Müll. *status* γ, FR. HUSTEDT, Bacillar. (1930) 91.

A form with fine striæ. Frustule length, 0.017 mm; breadth, 0.0085. Rare. A fresh-water species.

MELOSIRA UNDULATA (Ehr.) Kütz.

Melosira undulata (Ehr.) Kütz., A. SCHMIDT, Atlas Diatom. (1892) pl. 180, figs. 1-14, 16-19, 21.

A robust species with thick frustules. Diameter, 0.054 mm. Common in tropical districts. Known from Aokiko, Kizaki, and Biwa Lakes.

CYCLOTELLA COMTA (Ehr.) Kütz.

Cyclotella comta (Ehr.) Kütz., FR. HUSTEDT, Bacillar. (1930) 103, fig. 69.

Valve circular; a central-area marking of minute beads, regularly decreasing to the border; about one-third of border strongly marked with radial striæ. Diameter of the valve, 0.01 to 0.014 mm. Striæ 15 in 0.01 mm. Common. Known from Kizaki and Biwa Lakes.

CYCLOTELLA STELLIGERA Cleve and Grun.

Cyclotella stelligera Cleve and Grun., FR. HUSTEDT, Bacillar. (1930) 100, fig. 65.

A minute species with a central-area marking of radiate stellate striæ. Diameter of the valves, 0.0065 to 0.007 mm. Reported from Kizaki Lake.

CYCLOTELLA MENEGHINIANA Kütz.

Cyclotella meneghiniana Kütz., FR. HUSTEDT, Bacillar. (1930) 100, fig. 67.

Valve circular with a hyaline central area. Diameter of the valve, 0.0051 to 0.007 mm. Differs from the type in being smaller.

STEPHANODISCUS CARCONENSIS Grun. var. PUSILLA Grun.

Stephanodiscus carconensis Grun. var. *pusilla* Grun., A. SCHMIDT, Atlas Diatom. (1901) pl. 228, figs. 11–17; SKVORTZOW, Diatoms Biwa Lake (1936) pl. 1, figs. 8, 9–11, 14, and 18.

Diameter of the valves, 0.027 to 0.03 mm. Rare in Ikeda and very common in Biwa Lake.

TABELLARIA FENESTRATA (Lyngb.) Kütz.

Tabellaria fenestrata (Lyngb.) Kütz., FR. HUSTEDT, Bacillar. (1930) 122–123, fig. 99.

Valve, breadth, 0.006 mm; length, 0.09 to 0.1. Rare. Reported from Kizaki and Biwa Lakes.

FRAGILARIA CONSTRUENS (Ehr.) Grun. var. VENTER (Ehr.) Grun.

Fragilaria construens (Ehr.) Grun. var. *venter* (Ehr.) Grun., FR. HUSTEDT, Bacillar. (1930) 141, fig. 138.

Valve lanceolate, attenuate at the ends. Length, 0.018 mm; breadth, 0.005. Striæ 14 in 0.01 mm. A fresh-water species.

SYNEDRA ULNA (Nitzsch) Ehr.

Synedra ulna (Nitzsch) Ehr., FR. HUSTEDT, Bacillar. (1930) 151–152, fig. 159a.

Valve linear with slightly subrostrate ends. Length, 0.3 mm; breadth, 0.0068. Striæ 9 in 0.01 mm. Reported from Kizaki and Biwa Lakes.

SYNEDRA ULNA (Nitzsch) Ehr. var. BICEPS (Kütz.).

Synedra ulna (Nitzsch) Ehr. var. *biceps* (Kütz.), FR. HUSTEDT, Bacillar. (1930) 154, fig. 166.

A variety with broad capitate ends. Length, 0.34 mm; breadth, 0.005. Common. Known from Kizaki Lake.

SYNEDRA AMPHICEPHALA Kütz. Plate 5, fig. 12.

Synedra amphicephala Kütz., FR. HUSTEDT, Bacillar. (1930) 156, fig. 173.

Valve linear, slightly attenuate towards the capitate ends. Length, 0.035 mm; breadth, 0.0025. Striæ 12 to 14 in 0.01 mm. Not common.

SYNEDRA RUMPENS Kütz. var. MENEGHINIANA Grun. Plate 1, fig. 6.

Synedra rumpens Kütz. var. *Meneghiniana* Grun., FR. HUSTEDT, Bacillar. (1930) 156, fig. 178.

Valve linear with subcapitate ends. Length, 0.062 mm; breadth, 0.004. Striæ robust, 15 in 0.01 mm. Reported from Kizaki and Biwa Lakes.

SYNEDRA RUMPENS Kütz. var. OKAMURÆ var. nov. Plate 4, figs. 10 and 11.

Valve linear with parallel margins, attenuate at the ends. Ends capitate. Length, 0.059 to 0.093 mm; breadth, 0.0034. Differs from the type in being larger and having broader striæ. Common in Ikeda Lake.

SYNEDRA PARASITICA (W. Smith).

Synedra parasitica (W. Smith), FR. HUSTEDT, Bacillar. (1930) 161, fig. 195.

Valve lanceolate with undulate middle part and pointed ends. Length, 0.022 mm; breadth, 0.0034. Striæ 16 in 0.01 mm. Not common. Reported from Kizaki and Biwa Lakes.

EUNOTIA FLEXUOSA Kütz. Plate 2, fig. 4.

Eunotia flexuosa Kütz., FR. HUSTEDT, Bacillar. (1930) 185, fig. 258.

Valve linear with parallel margins, flexous, with undulate and capitate ends. Length, 0.1 mm; breadth, 0.0028. Striæ 18 in 0.01 mm. Common.

EUNOTIA TENELLA (Grun.) Hust. Plate 4, fig. 6.

Eunotia tenella (Grun.) Hust., FR. HUSTEDT, Bacillar. (1930) 176, fig. 220.

Valve minute, linear, arcuate, and slightly attenuate. Length, 0.023 mm; breadth, 0.0034. Striæ 15 in 0.01 mm. Uncommon. Known from marshy waters.

COCCONEIS PLACENTULA (Ehr.) var. EUGLYPTA (Ehr.) Cleve.

Cocconeis placentula (Ehr.) var. *euglypta* (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 190, fig. 261.

Valve ovate, crossed by ten broad, longitudinal, blank, undulating bands. Length, 0.025 mm; breadth, 0.015. A fresh-water species. Reported from Biwa Lake.

ACHNANTHES MINUTISSIMA Kütz. var. CRYPTOCEPHALA Grun.

Achnanthes minutissima Kütz. var. *cryptocephala* Grun., FR. HUSTEDT, Bacillar. (1930) 198, fig. 276.

Valve linear-elliptic, gradually attenuate towards the ends. Upper valve with a narrow, linear, axial area. Lower valve with a large, outwardly dilated, central area. Striæ very fine,

35 in 0.01 mm. Length, 0.017 mm; breadth, 0.0025. Common. Reported from Kizaki Lake.

ACHNANTHES PINNATA Hust. var. JAPONICA Hust.

Achnanthes pinnata Hust. var. *japonica* HUSTEDT, Bacillar. aus dem Aokikosee in Japan 161, pl. 5, figs. 12–15.

Valve minute, ovate with broad ends. Upper and lower valves with linear axial areas. Striæ radiate, 18 in 0.01 mm. Length, 0.006 mm; breadth 0.0028 Common. Reported from Aokiko, Kizaki, and Biwa Lakes.

ACHNANTHES CLEVEI Grun.

Achnanthes Clevei Grun., FR. HUSTEDT, Bacillar. (1930) 203, fig. 294.

Valve lanceolate with attenuate ends. Length, 0.013 mm; breadth, 0.005. Not common. Reported from Biwa Lake.

ACHNANTHES LINEARIS W. Smith var. NIPPONICA var. nov. Plate 1, figs. 24 and 25.

Valve linear with broad rounded ends. Upper and lower valves with narrow, linear, axilar areas. Central area of the lower valve with somewhat dilated striæ Length, 0.015 mm; breadth, 0.0034. Striæ 28 in 0.01 mm Not common.

ACHNANTHES KIZAKI Skvortzow. Plate 2, fig. 8.

Achnanthes Kizaki SKVORTZOW, Diatoms Kizaki Lake (1936) pl. 2, fig 25.

Valve elongate, gibbous in the middle with broad capitate ends. Upper valve with narrow, linear, central and axilar areas. Lower valve with a rectangular central area. Length, 0.013 mm; breadth, 0.0025. Known from Kizaki Lake. Uncommon.

ACHNANTHES OKAMURAE sp. nov. Plate 1, fig. 15.

Valve linear-elliptic, attenuate towards the ends. Upper and lower valves with narrow, linear, central and axial areas. Striæ slightly radiate. Length, 0.011 to 0.013 mm; breadth, 0.0028 to 0.003. Uncommon in Ikeda Lake. A distinct species akin to *A. linearis*.

RHOICOSPHENIA CURVATA (Kütz.) Grun.

Rhoicosphenia curvata (Kütz.) Grun., FR. HUSTEDT, Bacillar. (1930) 211, fig. 311.

Valve clavate, attenuate towards the ends. Length, 0.04 mm; breadth, 0.0068. Upper valve with narrow axial area and parallel striæ. Lower valve with elongate central area. Common. Reported from Kizaki and Biwa Lakes.

MASTOGLOIA ELLIPTICA Agardh var. **DANSEI** (Thwaites) Grun. Plate 1, fig. 11.

Mastogloia elliptica Agardh var. *dansei* (Thwaites) Grun., FR. HUSTEDT, Bacillar. (1930) 217, fig. 318.

Valve linear-elliptic with cuneate ends. Length, 0.037 mm; breadth, 0.01. Striæ 15 in 0.01 mm. Uncommon. Common in brackish or almost fresh water.

AMPHIPLEURA PELLUCIDA Kütz.

Amphipleura pellucida Kütz., FR. HUSTEDT, Bacillar. (1930) 218, fig. 321.

Valve linear-lanceolate with acute ends. Length, 0.085 mm; breadth, 0.006. Common. Known from fresh or slightly brackish water. Reported from Kizaki Lake.

AMPHIPLEURA PELLUCIDA Kütz. var. **RECTA** Kitton. Plate 2, fig. 2.

Amphipleura pellucida Kütz. var. *recta* KITTON, Journ. Quekett Microsc. Club (2) 2, 21, pl. 4, fig. 4.

Valve linear with gently cuneate ends. Length, 0.185 to 0.224 mm; breadth, 0.018 to 0.02. Striæ longitudinal, 25 to 30 in 0.01 mm. Puncta 25 to 30 in 0.01 mm. Common. Reported from Kizaki and Biwa Lakes. Found by Kitton in Nipponese oysters.

FRUSTULIA VULGARIS Thwaites.

Frustulia vulgaris Thwaites, FR. HUSTEDT, Bacillar. (1930) 221, fig. 327.

Valve narrow-lanceolate with subrostrate, obtuse ends. Length, 0.049 mm; breadth, 0.0085. Uncommon. Reported from Kizaki Lake.

FRUSTULIA RHOMBOIDES (Ehr.) de Toni var. **SAXONICA** (Rabh.) de TONI fo. **CAPITATA** A. Mayer. Plate 2, fig. 14.

Frustulia rhomboides (Ehr.) de Toni var. *saxonica* (Rabh.) de Toni fo. *capitata* A. Mayer, FR. HUSTEDT, Bacillar. (1930) 221.

Valve lanceolate with rostrate ends. Length, 0.054 mm; breadth, 0.014. Striæ 24 in 0.01 mm. Common. Reported from Kizaki Lake.

FRUSTULIA RHOMBOIDES (Ehr.) de Toni var. **AMPHIPLEUROIDES** Grun. Plate 4, fig. 12.

Frustulia rhomboides (Ehr.) de Toni var. *amphipleuroides* Grun., FR. HUSTEDT, Bacillar. (1930) 221, fig. 326.

Valve lanceolate with attenuate ends. Central nodule large, elongate. Median line slightly eccentric. Length, 0.127 mm; breadth, 0.017. Uncommon. Reported from Kizaki and Biwa Lakes.

GYROSIGMA KÜTZINGII (Grun.) Cleve. Plate 1, fig. 4.

Gyrosigma Kützingii (Grun.) Cleve, FR. HUSTEDT, Bacillar. (1930) 224, fig. 333.

Valve sigmoid, lanceolate, with acute ends. Length, 0.153 mm; breadth, 0.018. Transverse striæ slightly radiate in the middle, 15 to 18 in 0.01 mm; longitudinal striæ 28 to 30 in 0.01 mm. Valves of Nipponese specimens are larger than those of the type from Europe. Common. Reported from Kizaki and Biwa Lakes.

GYROSIGMA ACUMINATUM (Kütz.) Rabh. Plate 1, fig. 6.

Gyrosigma acuminatum (Kütz.) Rabh., FR. HUSTEDT, Bacillar. (1930) 222, fig. 329.

Valve sigmoid, lanceolate, with acute ends. Transverse and longitudinal striæ equidistant, about 18 in 0.01 mm. Common. Reported from Kizaki and Biwa Lakes.

GYROSIGMA SPENCERII (W. Smith) Cleve var. OKAMURAE var. nov. Plate 1, figs. 9 and 10.

Valve linear-lanceolate, sigmoid and obtuse. Length, 0.127 to 0.137 mm; breadth, 0.018 to 0.028. Transverse and longitudinal striæ equidistant, 12 to 15 in 0.01 mm. Differs from var. *Smithii* Grun. in having robust striæ. Common.

CALONEIS SILICULA (Ehr.) Cleve.

Caloneis silicula (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 236, fig. 362.

Valve gibbous in the middle, ends obtuse. Length, 0.034 mm; breadth, 0.008. Central area with a broad stauros. Striæ 25 in 0.01 mm. Not common.

CALONEIS SILICULA (Ehr.) Cleve var. TUMIDA Hust.

Caloneis silicula (Ehr.) Cleve var. *tumida* Hust., FR. HUSTEDT, Bacillar. (1930) 238, fig. 367.

Valve gibbous in the middle and attenuate at the ends. Length, 0.076 mm; breadth, 0.013. Striæ 18 in 0.01 mm. Uncommon. Reported from Biwa Lake.

NEIDIUM IRIDIS (Ehr.) Cleve var. AMPHIGOMPHUS (Ehr.) Van Heurck fo. ANGUSTA fo. nov. Plate 4, fig. 4.

Valve linear with cuneate ends. Length, 0.072 mm; breadth, 0.016. Striæ 18 in 0.01 mm. The European forms are larger and broader. Rare in Ikeda Lake.

NEIDIUM IRIDIS (Ehr.) Cleve var. AMPLIATA (Ehr.) Cleve.

Neidium iridis (Ehr.) Cleve var. *ampliata* (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 245, fig. 381.

Valve narrow, elliptic, with broad, subrostrate ends. Length, 0.059 mm, breadth, 0.013. Striæ 18 in 0.01 mm. Common.

NEIDIUM AFFINE (Ehr.) Cleve var. AMPHIRHYNCHUS (Ehr.) Cleve. Plate 4, fig. 1.

Neidium affine (Ehr.) Cleve var. *amphirhynchus* (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 243, fig. 377.

Valve linear with protracted and rostrate ends. Length, 0.098 mm; breadth, 0.02. Striæ 21 in 0.01 mm. Common.

NEIDIUM OBLIQUESTRIATUM A. S. var. NIPPONICA Skvortzow.

Neidium obliquestriatum A. S. var. *nipponica* SKVORTZOW, Diatoms Kizaki Lake (1936) pl. 4, figs. 5, 22.

Valve lanceolate, gradually attenuate towards the ends or slightly subrostrate. Length, 0.085 mm; breadth, 0.022. Striæ oblique, 18 in 0.01 mm. Common. Known from Kizaki and Biwa Lakes.

NEIDIUM DUBIUM (Ehr.) Cleve.

Neidium dubium (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 245, fig. 384.

Valve elliptic with obtuse and subrostrate ends. Length, 0.042 mm; breadth, 0.013. Striæ fine, 25 in 0.01 mm. Reported from Kizaki Lake.

NEIDIUM DUBIUM (Ehr.) Cleve fo. CONSTRICTA Hustedt. Plate 2, fig. 14.

Neidium dubium (Ehr.) Cleve fo. *constricta* HUSTEDT, Bacillar. (1930) 246, fig. 384*b*.

Differs from the type in its constricted margin. Length, 0.037 mm; breadth, 0.015. Striæ 18 in 0.01 mm. Common. Reported from Biwa Lake.

DIPLONEIS OVALIS (Hilse) Cleve. Plate 1, fig. 8.

Diploneis ovalis (Hilse) Cleve, FR. HUSTEDT, Bacillar. (1930) 249, fig. 390.

Valve broad-elliptic. Central nodule large, rounded. Transverse rows of alveoli 10 to 12 in 0.01 mm. Length, 0.034 to 0.079 mm; breadth, 0.012 to 0.013. Striæ 10 to 12 in 0.01 mm. Uncommon. Reported from Kizaki, Aokiko, and Biwa Lakes.

DIPLONEIS OVALIS (Hilse) Cleve var. OBLONGELLA (Naegeli) Cleve.

Diploneis ovalis (Hilse) Cleve var. *oblongella* (Naegeli) Cleve, FR. HUSTEDT, Bacillar. (1930) 249, fig. 391.

Valve linear-elliptic. Length, 0.017 mm; breadth, 0.0063. Striæ 15 in 0.01 mm. Uncommon. Reported from Biwa Lake.

DIPLONEIS ELLIPTICA (Kütz.) Cleve var. LADOGENSIS Cleve.

Diploneis elliptica (Kütz.) Cleve var. *ladogensis* Cleve. FR. HUSTEDT, Bacillar. (1930) 250, fig. 390.

Valve elliptic with broad, rounded ends. Transverse costæ 8 in 0.01 mm, irregularly anastomosing with a few, longitudinal, undulating costæ. Length, 0.051 mm; breadth, 0.034. Striæ 8 in 0.01 mm. Uncommon. Reported from Kizaki Lake.

DIPLONEIS SMITHII (Bréb.) Cleve var. NIPPONICA Skvortzow.

Diploneis Smithii (Bréb.) Cleve var. *nipponica* SKVORTZOW, Diatoms Kizaki Lake (1936) pl. 2, figs. 1, 9.

Valve elliptic with a small, quadrate, central nodule. Furrows arcuate, closely following the central nodule. Costæ alternating with double rows of alveoli. Length, 0.073 mm; breadth, 0.034. Not common. Reported from Kizaki Lake.

DIPLONEIS PUELLA (Schumann) Cleve. Plate 1, fig. 25.

Diploneis puella (Schumann) Cleve, FR. HUSTEDT, Bacillar. (1930) 250, fig. 394.

Valve elliptic with broad, rounded ends. Central nodule small, quadrate. Furrows narrow. Costæ 18 in 0.01 mm. Alveoli indistinct. Differs from the type in having broad, rounded ends. Length, 0.015 mm; breadth, 0.0068. Striæ 18 in 0.01 mm. Common in Ikeda Lake. Reported from Kizaki and Biwa Lakes.

DIPLONEIS OCULATA (Bréb.) Cleve.

Diploneis oculata (Bréb.) Cleve, FR. HUSTEDT, Bacillar. (1930) 250, fig. 392.

Valve elongate-elliptic. Length, 0.017 mm; breadth, 0.0068. Central nodule small. Costæ 15 to 18 in 0.01 mm. Common. Reported from Kizaki and Aokiko Lakes.

STAURONEIS PHŒNICENTERON Ehr. fo. GRACILIS Dip.

Stauroneis phœnicenteron Ehr. fo. *gracilis* Dip., FR. HUSTEDT, Bacillar. (1930) 255.

Valve lanceolate with long-attenuate ends. Length, 0.081 mm; breadth, 0.015. Striæ 18 in 0.01 mm. Common.

STAURONEIS SIGNATA (Meister) comb. nov.

Stauroneis phœnicenteron Ehr. var. *signata* MEISTER, Kieselalgen aus Asien (1932) 45, figs. 149, 150.

Valve lanceolate with a broad middle part. Length, 0.093 to 0.15 mm; breadth, 0.015 to 0.036. Striæ 18 in 0.01 mm. Stau-

ros broad with marginal, alternately longer and shorter striæ. Rare. Reported by Fr. Meister in Ta-Hu and Kuang-Fong in China, and by me in Great Hingan, northern Manchuria, and at Seiriori in Chosen, Nippon.

STAURONEIS SIGNATA (Meister) sub. fo. GRACILIS fo. nov.

A form with a smaller and narrower valve. Length, 0.093 mm; breadth, 0.015. Striæ 18 in 0.01 mm. Not common.

STAURONEIS ANCEPS Ehr.

Stauroneis anceps Ehr., FR. HUSTEDT, Bacillar. (1930) 256, fig. 405.

Valve lanceolate with rostrate ends. Length, 0.061 mm, breadth, 0.012. Common. Reported from Kizaki Lake.

STAURONEIS ANCEPS Ehr. fo. GRACILIS (Ehr.) Cleve.

Stauroneis anceps Ehr. fo. *gracilis* (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 256, fig. 406.

Valve lanceolate, with very fine striæ. Length, 0.052 mm, breadth, 0.015. Not common. Reported from Kizaki Lake.

ANOMOEONEIS EXILIS (Kütz.) Cleve var. LANCEOLATA A. Mayer. Plate 2, fig. 3.

Anomoeoneis exilis (Kütz.) Cleve var. *lanceolata* A. Mayer, FR. HUSTEDT, Bacillar. (1930) 264.

Valve lanceolate with protracted ends. Length, 0.027 mm; breadth, 0.005. Striæ very fine, about 30 in 0.01 mm. Uncommon. Reported from alpine regions.

NAVICULA CUSPIDATA Kütz. Plate 4, fig. 8.

Navicula cuspidata Kütz., FR. HUSTEDT, Bacillar. (1930) 268, fig. 433.

Valve rhombic-lanceolate, with acute ends. Length, 0.085 mm; breadth, 0.03. Common. Reported from Kizaki Lake

NAVICULA HALOPHILA (Grun.) Cleve var. OKAMURÆ var. nov. Plate 4, fig. 6.

Valve linear-lanceolate, with parallel margins in the middle and subrostrate, obtuse ends. Length, 0.068 mm, breadth, 0.017. Striæ 13 to 14 in 0.01 mm. Differs from the type in having obtuse ends and broader striæ. The type is known from brackish water.

NAVICULA VENTRALIS Krasske var. OKAMURÆ var. nov. Plate 1, figs. 17 and 18.

Valve gibbous in the middle, with broad capitate ends. Length, 0.013 to 0.018 mm; breadth, 0.006. Striæ 25 to 30 in 0.01 mm. Median line straight, axial area moderately broad, dilated in the middle. Central area a broad stauros, widened

and truncate outward. Differs from the type in its shorter ends. Common.

NAVICULA MUTICA Kütz.

Navicula mutica Kütz., FR. HUSTEDT, Bacillar. (1930) 274, fig. 453a.

Valve lanceolate, with obtuse ends. Length, 0.015 mm; breadth, 0.006. Not common. Reported from Kizaki Lake.

NAVICULA PUPULA Kütz. var. CAPITATA Hust.

Navicula pupula Kütz. var. *capitata* FR. HUSTEDT, Bacillar. (1930) 281, fig. 467a.

Valve linear-lanceolate, with broad capitate ends. Length, 0.037 mm; breadth, 0.0085. Striæ 18 to 20 in 0.01 mm. Common. Reported from Kizaki and Biwa Lakes.

NAVICULA PUPULA Kütz. var. ELLIPTICA Hust. Plate 3, fig. 2

Navicula pupula Kütz. var. *elliptica* FR. HUSTEDT, Bacillar. (1930) 282, fig. 467d.

Valve minute, lanceolate and obtuse. Length, 0.013 mm; breadth, 0.005. Striæ 24 to 25 in 0.01 mm. Not common.

NAVICULA PUPULA Kütz. var. RECTANGULARIS (Greg.) Grun.

Navicula pupula Kütz. var. *rectangularis* (Greg.) Grun., FR. HUSTEDT, Bacillar. (1930) 281, fig. 467b.

Valve linear, with parallel margins and broad, obtuse ends. Length, 0.039 mm; breadth, 0.01. Striæ 18 in 0.01 mm. Common. Reported from Kizaki and Biwa Lakes.

NAVICULA SUBTILISSIMA Cleve var. OKAMURAE var. nov. Plate 4, fig. 11

Valve slightly siliceous, linear-lanceolate, attenuate at the broad, subcapitate ends. Length, 0.017 mm; breadth, 0.003. Differs from the type in its broad, subcapitate ends. Not common.

NAVICULA RHYNCHOCEPHALA Kütz.

Navicula rhynchocephala Kütz., FR. HUSTEDT, Bacillar. (1930) 296, fig. 501.

Valve lanceolate, with attenuate ends. Length, 0.042 mm; breadth, 0.0085. Striæ 12 in 0.01 mm. Common. Reported from Kizaki and Biwa Lakes.

NAVICULA ROSTELLATA Kütz.

Navicula rostellata Kütz., FR. HUSTEDT, Bacillar. (1930) 297, fig. 502.

Valve linear-lanceolate, gradually attenuate towards the ends. Length, 0.037 mm; breadth, 0.0085. Striæ 12 in 0.01 mm. Not common. Reported from Kizaki Lake.

NAVICULA HUNGARICA Grun. var. CAPITATA (Ehr.) Cleve. Plate 1, fig. 21.

Navicula hungarica Grun. var. *capitata* (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 298, fig. 508.

Valve elliptic-lanceolate, undulate with rostrate ends. Length, 0.017 mm; breadth, 0.005. Striæ 9 in 0.01 mm. Common.

NAVICULA RADIOSA Kütz.

Navicula radiosa Kütz., FR. HUSTEDT, Bacillar. (1930) 299, fig. 512.

Valve narrow, lanceolate, gradually tapering from the middle to the subacute ends. Length, 0.091 mm; breadth, 0.01. Striæ 9 to 10 in 0.01 mm. Not common. Reported from Kizaki Lake.

NAVICULA RADIOSA Kütz. fo. NIPPONICA Skv.

Navicula radiosa Kütz. fo. *nipponica* SKVORTZOW, Diatoms Biwa Lake (1930) pl. 2, fig. 2; pl. 13, fig. 20.

Differs from the type in having a narrower valve. Length, 0.042 mm; breadth, 0.006. Striæ not striolate, 12 in 0.01 mm Not common. Known from Biwa Lake.

NAVICULA FALAISIENSIS Grun. var. LANCEOLA Grun. Plate 1, fig. 22.

Navicula falaisiensis Grun. var. *lanceola* Grun., FR. HUSTEDT, Bacillar. (1930) 302, fig. 524.

Valve narrow, linear-lanceolate with rostrate ends. Central area narrow, striæ slightly radiate. Length, 0.023 mm; breadth, 0.005. Striæ 18 in 0.01 mm. Reported from Kizaki Lake.

NAVICULA ANGLICA Ralfs. Plate 2, fig. 13.

Navicula anglica Ralfs, FR. HUSTEDT, Bacillar. (1930) 303, figs. 530–531.

Valve elliptic with subrostrate ends. Length, 0.022 mm; breadth, 0.009. Striæ 13 in 0.01 mm. Rare. Known from Kizaki Lake.

NAVICULA GASTRUM Ehr.

Navicula gastrum Ehr., FR. HUSTEDT, Bacillar. (1930) 305, fig. 537.

Valve elliptic with subrostrate ends. Striæ radiate in the middle, alternately longer and shorter. Length, 0.037 mm; breadth, 0.015. A fresh-water species.

NAVICULA LANCEOLATA (Agardh) Kütz. Plate 2, fig. 15.

Navicula lanceolata (Agardh) Kütz., FR. HUSTEDT, Bacillar. (1930) 305, fig. 540.

Valve lanceolate with attenuate ends. Length, 0.027 to 0.042 mm; breadth, 0.0063 to 0.0085. Striæ lineolate, radiate, 15 in 0.01 mm. Common. Reported from Kizaki Lake.

NAVICULA HASTA Pant. fo. MINOR fo. nov. Plate 1, fig. 26.

Differs from the type in having minute valves. Length, 0.042 mm; breadth, 0.009. Striæ lineolate, 12 in 0.01 mm. Not common.

NAVICULA EXIGUA (Greg.) O. MÜLL.

Navicula exigua (Greg.) O. MÜLL., FR. HUSTEDT, Bacillar. (1930) 305, fig. 52.

Valve lanceolate with rostrate-capitate ends. Length, 0.023 mm; breadth, 0.0065. Striæ radiate, 12 in 0.01 mm. Three median striæ much shorter than the others. Not common. Reported from Kizaki and Biwa Lakes.

NAVICULA GLOBULIFERA Hust. var. NIPPONICA Skvortzow.

Navicula globulifera Hust. var. *nipponica* SKVORTZOW, Diatoms Kizaki Lake (1936) pl. 3, fig. 10.

Valve lanceolate, attenuate. Length, 0.059 mm; breadth, 0.0068 to 0.007. Striæ radiate, 11 to 12 in 0.01 mm. Not common. Reported from Kizaki Lake.

NAVICULA TUSCULA (Ehr.) Grun. Plate 1, fig. 11.

Navicula tuscula (Ehr.) Grun., FR. HUSTEDT, Bacillar. (1930) 308, fig. 552.

Valve elliptic with protracted ends. Length, 0.062 mm; breadth, 0.16. Striæ crossed by several, irregularly undulating, longitudinal bands, 11 in 0.01 mm. Common in Ikeda Lake. Known from fresh and slightly brackish water.

NAVICULA IKARI Skvortzow var. NIPPONICA var. nov. Plate 1, fig. 16.

Valve linear-elliptic, slightly attenuate towards the broad, obtuse ends. Length, 0.018 mm; breadth, 0.0038. Axial area narrow, central area a broad triangular stauros. Striæ very fine, about 35 in 0.01 mm. Differs from the type in being smaller and having finer striæ. The type is known from Biwa Lake.

NAVICULA MINIMA Grun. var. OKAMURÆ var. nov. Plate 1, fig. 23.

Valve linear-elliptic, broad and obtuse. Length, 0.012 mm; breadth, 0.005. Striæ radiate, about 24 to 28 in 0.01 mm. Differs from the type in the undulate valve. Rare. *Navicula minima* Grun. is reported from Europe.

NAVICULA ATOMARIUS Skvortzow. Plate 1, fig. 19.

Navicula atomarius SKVORTZOW, Diatoms Kizaki Lake (1936) pl. 2, fig. 13.

Valve linear, convex and obtuse. Length, 0.009 mm; breadth, 0.0036. Striæ very fine, about 40 in 0.01 mm. Central area

broad, axial area narrow and linear. Not common. Reported from Kizaki Lake.

PINNULARIA MICROSTAURON (Ehr.) Cleve. Plate 3, fig. 11.

Pinnularia microstauron (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 320, fig. 582.

Valve linear-lanceolate with nearly parallel margins and rostrate ends. Length, 0.039 mm; breadth, 0.01. Striæ 12 in 0.01 mm. Not common. Reported from Kizaki Lake.

PINNULARIA KARELICA Cleve var. JAPONICA Hust.

Pinnularia karelica Cleve var. *japonica* HUSTEDT, Bacillar. aus dem Aokikosee in Japan 165, pl. 5, fig. 3.

Valve linear with broad and obtuse ends. Length, 0.054 mm; breadth, 0.013. Common. Reported from Aokiko, Kizaki, and Biwa Lakes.

PINNULARIA LEGUMEN Ehr.

Pinnularia legumen Ehr., FR. HUSTEDT, Bacillar. (1930) 322, fig. 587.

Valve linear-lanceolate, triundulate with capitate ends. Length, 0.096 to 0.0119 mm; breadth, 0.012 to 0.017. Striæ 9 in 0.01 mm. Common. Reported from Kizaki Lake.

PINNULARIA MICROSTAURON (Ehr.) Cleve var. KIZAKENSIS Skvortzow.

Pinnularia microstauron (Ehr.) Cleve var. *kizakensis* SKVORTZOW, Diatoms Kizaki Lake (1936) pl. 6, fig. 7.

Pinnularia divergens W. Smith var. *japonica* MEISTER, Beiträge zur Bacillar. Japans 2 (1914) 229, pl. 3, fig. 9 (not 3).

Valve linear-lanceolate with attenuate and truncate ends. Length, 0.047 mm; breadth, 0.01. Striæ 12 to 15 in 0.01 mm. Axial area in the middle dilated to an elliptic space only on one side to the transverse fascia. Not common. Known from the Botanical Garden of Tokyo and from Kizaki Lake.

PINNULARIA PLATYCEPHALA (Ehr.) Cleve.

Pinnularia platycephala (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 324, fig. 593.

Valve linear, slightly triundulate with subcapitate ends. Length, 0.086 mm; breadth, 0.017. Striæ 9 in 0.01 mm. Not common. Known from Kizaki Lake.

PINNULARIA BOREALIS Ehr. Plate 6, figs. 5 and 17.

Pinnularia borealis Ehr., FR. HUSTEDT, Bacillar. (1930) 326, fig. 597.

Valve linear or linear-elliptic with broad ends. Length, 0.042 to 0.051 mm; breadth, 0.006 to 0.01. Striæ robust, slightly ra-

distc, 6 in 0.01 mm. Common. Known from Kizaki and Biwa Lakes.

PINNULARIA GIBBA Ehr.

Pinnularia gibba Ehr., FR. HUSTEDT, Bacillar (1930) 327 fig. 600.

Valve linear, gibbous in the middle and with capitate ends. Length, 0.059 to 0.083 mm; breadth, 0.0085 to 0.012. Striæ 9 to 10 in 0.01 mm. Common. Reported from Kizaki and Biwa Lakes.

PINNULARIA GIBBA Ehr. fo. SUBUNDULATA Mayer.

Pinnularia gibba Ehr. fo. *subundulata* Mayer, FR. HUSTEDT, Bacillar, (1930) 327, fig. 601.

Differs from the type in its slightly undulate margins. Length 0.06 mm; breadth, 0.0085 to 0.009. Striæ 11 to 12 in 0.01 mm. Common. Known from Kizaki Lake.

PINNULARIA GIBBA Ehr. var. NIPPONICA Skvortzow.

Pinnularia gibba Ehr var. *nipponica* SKVORTZOW, Diatoms Kizaki Lake (1936) pl. 7, fig. 10.

Valve slightly triundulate with capitate ends. Length, 0.098 mm, breadth, 0.017. Striæ 9 to 10 in 0.01 mm. Differs from Kizaki specimens in its broader valves. Not common in Ikeda Lake.

PINNULARIA GIBBA Ehr. var. OKAMURÆ var. nov. Plate 2, fig. 7.

Valve almost linear with broad, rounded ends. Axial area linear in the middle, forming a broad transverse fascia. Length, 0.057 mm; breadth, 0.012. Striæ 10 to 11 in 0.01 mm. Differs from the type in its parallel margins and its small size. Common.

PINNULARIA LIGNITICA Cleve. Plate 4, fig. 3.

Pinnularia lignitica Cleve, A. SCHMIDT, Atlas Diatom (1914) pl. 312, fig. 7.

Valve rhombic-lanceolate, gradually tapering from the middle to the subacute ends. Length, 0.076 mm; breadth, 0.018. Striæ radiate, 12 in 0.01 mm, with two, distinct, longitudinal lines. Common. Known as a fossil in Nipponese lignite and living in Kizaki Lake.

PINNULARIA HUSTEDTI Meister var. NIPPONICA var. nov. Plate 3, fig. 4.

Valve linear, slightly undulate in the middle, attenuate to the capitate ends. Length, 0.205 mm; breadth, 0.025. Striæ 6 in 0.01 mm. Longitudinal bands distinct. Common. It differs

from the type in its more robust striæ and broader valves. The type is known from Canton River, China.

PINNULARIA MAJOR (Kütz.) Cleve.

Pinnularia major (Kütz.) Cleve, FR. HUSTEDT, Bacillar. (1930) 331, fig. 614.

Valve linear, gibbous in the middle and at the rounded ends. Length, 0.147 mm, breadth, 0.022. Median line not complex Striæ 7 in 0.01 mm, crossed by a narrow band. Common. Reported from Kizaki Lake.

PINNULARIA VIRIDIS (Nitzsch) Ehr. var. FALLAX Cleve.

Pinnularia viridis (Nitzsch) Ehr var *fallax* Cleve, A. SCHMIDT, Atlas Diatoms (1876) pl. 43, fig. 24; pl. 46, figs. 10, 11.

Valve elliptic-linear. Length, 0.085 mm; breadth, 0.013. Striæ almost parallel, 9 in 0.01 mm, unilaterally interrupted Common. Reported from Kizaki and Biwa Lakes

PINNULARIA GENTILIS (Donk.) Cleve.

Pinnularia gentilis (Donk.) Cleve, FR. HUSTEDT, Bacillar. (1930), 335, fig. 618.

Valve linear with parallel margins and broad, rounded ends. Length, 0.22 mm, breadth, 0.032. Striæ 6 in 0.01 mm. Median line complex. Not common.

PINNULARIA KIZAKIENSIS sp. nov. Plate 3, fig. 6.

Valve linear-lanceolate with broad, subcapitate ends. Length, 0.078 mm; breadth, 0.013. Median line filiform. Axial area distinct, in the middle dilated to an elliptic space, on one side to a transverse fascia. Striæ 9 in 0.01 mm, divergent in the middle, convergent at the ends, with a distinct, longitudinal band. Differs from *P. rangoonensis* Grun.[1] in its distinct band. Common.

AMPHORA OVALIS Kütz.

Amphora ovalis Kütz., FR. HUSTEDT, Bacillar. (1930) 342, fig. 628.

Frustule robust and ovate. Length, 0.083 mm; breadth, 0.037. Striæ 9 to 10 in 0.01 mm. Common. Reported from Biwa Lake.

AMPHORA OVALIS Kütz. forma GRACILIS Kütz.

Amphora ovalis Kütz., A. SCHMIDT, Atlas Diatom. (1875) pl. 26, fig. 101.

Differs from the type in its narrower valve. Length, 0.027 mm; breadth, 0.005. Striæ 14 to 15 in 0.01 mm. Common. Known from Kizaki Lake.

[1] Ehrenberg, Microgeologie (1854) 33, pl. 2, fig. 7.

AMPHORA OVALIS Kütz. var. LIBYCA (Ehr.) Cleve.

Amphora libyca Ehr., A. SCHMIDT, Atlas Diatom. (1875) pl. 26, fig. 105.

Valve lunate. Length, 0.045 mm; breadth, 0.022. Central area distinct on the dorsal side, with an irregular blank band across the striæ. Uncommon in Ikeda Lake. Reported from Kizaki and Biwa Lakes.

AMPHORA OVALIS Kütz. var. PEDICULUS Kütz.

Amphora ovalis Kütz. var. *pediculus* Kütz., FR. HUSTEDT, Bacillar. (1930) 343, fig. 629.

Valve lunate. Length, 0.012 mm; breadth, 0.0034. Central area distinct. Uncommon. Known from fresh and slightly brackish water. Reported from Kizaki and Biwa Lakes.

AMPHORA NORMANI Rabh. Plate 1, fig. 12.

Amphora Normani Rabh., FR. HUSTEDT, Bacillar. (1930) 342, fig. 630.

Valve lunate with undulate dorsal and ventral sides and capitate ends. Length, 0.017 mm; breadth, 0.0085. Striæ 15 in 0.01 mm. Known from alpine regions. Reported from Kizaki Lake.

CYMBELLA MICROCEPHALA Grun.

Cymbella microcephala Grun., FR. HUSTEDT, Bacillar. (1930) 351, fig. 637.

Valve slightly asymmetric, lanceolate, with subcapitate ends. Length, 0.017 mm; breadth, 0.0034. Striæ very fine, 30 in 0.01 mm. Not common. Known from Kizaki Lake.

CYMBELLA LEPTOCEROS (Ehr.) Grun. Plate 1, fig. 8.

Cymbella leptoceros (Ehr.) Grun., FR. HUSTEDT, Bacillar. (1930) 353, fig. 645.

Valve asymmetric, lanceolate, with slightly gibbous ventral margin. Ends attenuate and obtuse. Length, 0.034 mm; breadth, 0.01. Striæ 12 in 0.01 mm. Not common.

CYMBELLA ALPINA Grun. fo. NIPPONICA fo. nov. Plate 1, fig. 6.

Valve slightly asymmetric, lanceolate, with obtuse ends. Length, 0.04 mm; breadth, 0.0085. Striæ lineolate, 12 in 0.01 mm. Differs from the type in the number of striæ. Not common.

CYMBELLA HETEROPLEURA Ehr. var. MINOR Cleve.

Cymbella sp., A. SCHMIDT, Atlas Diatom. (1876) pl. 9, figs. 51, 52.

Valve slightly asymmetric, with rostrate and truncate ends. Length, 0.074 mm; breadth, 0.022. Striæ 9 in 0.01 mm. An Arctic species. Reported from Kizaki and Biwa Lakes.

CYMBELLA PROSTRATA (Berkeley) Cleve.

Encyonema prostratum Ralfs, A. SCHMIDT, Atlas Diatom. (1876) pl. 10, figs. 64–69.

Valve strongly asymmetric, with obtuse ends. Length, 0.037 mm; breadth, 0.01. Striæ striolate, dorsal and ventral 9 in 0.01 mm. Common. Reported from Kizaki and Biwa Lakes.

CYMBELLA TURGIDA (Greg.) Cleve fa. MINOR fa. nov. Plate 1, fig. 39.

Valve slightly asymmetric, lanceolate, gradually tapering from the middle to the obtuse ends. Length, 0.02 mm, breadth, 0.006. Striæ 12 in 0.01 mm. The type is common in the Tropics. Our specimens are smaller than the type. Common.

CYMBELLA VENTRICOSA Kütz.

Cymbella ventricosa Kütz., FR. HUSTEDT, Bacillar. (1930) 359, fig. 661.

Valve lunate, with gibbous ventral margin. Length, 0.017 mm; breadth, 0.005. Striæ 12 in 0.01 mm. Common. Reported from Kizaki and Biwa Lakes.

CYMBELLA GRACILIS (Rabh.) Cleve.

Cymbella gracilis (Rabh.) Cleve, FR. HUSTEDT, Bacillar. (1930) 359, fig. 663.

Valve elongate, narrow, with gently arcuate dorsal, and slightly arcuate ventral, margins. Length, 0.027 mm; breadth, 0.004. Striæ 12 in 0.01 mm. Common. Reported from Kizaki Lake.

CYMBELLA HYBRIDA Grun.

Cymbella hybrida Grunow, CLEVE, Synopsis Navicul. Diatom. (1894) 1: 166, pl. 4, fig. 23.

Valve linear, almost symmetric, with parallel margins and rostrate ends. Length, 0.064 mm, breadth, 0.012. Striæ finely punctate, 12 in 0.01 mm. Common. Reported from Kizaki Lake, Nippon, and from Hanka Lake, Siberia.

CYMBELLA TURGIDULA Grun. Plate 1, fig. 31.

Cymbella turgidula Grun., A. SCHMIDT, Atlas Diatom. (1931) pl. 376, fig. 8.

Valve asymmetric, lanceolate, tapering from the middle to the obtuse ends. On the ventral side of the central nodule are two small puncta, ending the median striæ. Common in Ikeda Lake. Reported from Kizaki Lake.

CYMBELLA CYMBIFORMIS (Agardh ? Kütz.) Van Heurck.

Cymbella cymbiformis (Agardh? Kütz.) VAN HEURCK.

Valve boat-shaped, with slightly gibbous ventral margin and obtuse ends. Length, 0.063 to 0.091 mm; breadth, 0.015 to 0.017.

Striæ 6 to 9 in 0.01 mm. On the ventral side of the central nodule is an isolated punctum at the end of the median striæ. Very common. Reported from Kizaki Lake.

CYMBELLA CISTULA (Hemp.) Grun.

Cymbella cistula (Hemp.) Grun., FR. HUSTEDT, Bacillar. (1930) 363, fig. 676a.

Valve boat-shaped. On the ventral side, near the central nodule, the striæ are interrupted by a narrow depression with five isolated puncta. Length, 0.042 mm; breadth, 0.01. Striæ 9 in 0.01 mm. Common. Reported from Kizaki and Biwa Lakes.

CYMBELLA ASPERA (Ehr.) Cleve. Plate 4, fig. 1.

Cymbella aspera (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 365, fig. 680.

Valve boat-shaped, with arcuate dorsal margin. Length, 0.17 mm; breadth, 0.034. Dorsal striæ 5, ventral 8, in 0.01 mm. Puncta 12 in 0.01 mm. Common. Reported from Kizaki Lake.

CYMBELLA AUSTRALICA A. S.

Cymbella australica A. S., A. SCHMIDT, Atlas Diatom. (1875) pl. 10, figs. 34, 35.

Valve boat-shaped. Length, 0.091 mm; breadth, 0.022. Striæ radiate in the middle, with a large stigma below the central nodule, 7 to 8 in 0.01 mm. Not common. Known from Australia, New Zealand, Nippon, and Hanka Lake, Siberia.

GOMPHONEMA ACUMINATUM Ehr. var. CORONATA (Ehr.) W. Smith.

Gomphonema acuminatum Ehr. var. *coronata* (Ehr.) W. Smith, FR. HUSTEDT, Bacillar. (1930) 370, fig. 684.

Valve biconstricted, with apiculate apex. Length, 0.055 mm; breadth, 0.008. Common. Reported from Kizaki and Biwa Lakes.

GOMPHONEMA AUGUR Ehr. var. GAUTIERI Van Heurck. Plate 2, fig. 17.

Gomphonema augur Ehr. var. *Gautieri* Van Heurck, FR. HUSTEDT, Bacillar. (1930) 372, fig. 689.

Valve biconstricted, with broad apex. Length, 0.061 mm; breadth, 0.013. Striæ 10 in 0.01 mm. Common. Reported from Kizaki and Biwa Lakes.

GOMPHONEMA AUGUR Ehr. var. OKAMURAE var. nov. Plate 4, fig. 12.

Valve clavate, with truncate-apiculate apex and narrow base. Length, 0.057 mm; breadth, 0.015. Central area short, unilateral, with two stigmata. Striæ 9 in 0.01 mm. Not common.

Differs from variety *Gautieri* by the presence of two isolated stigmata.

GOMPHONEMA INTRICATUM Kütz. Plate 3, fig. 7.

Gomphonema intricatum Kütz. FR. HUSTEDT, Bacillar. (1930) 375, fig. 697.

Valve narrow-clavate, gradually tapering from the middle to the subacute ends. Apex broad. Length, 0.019 mm; breadth, 0.0068. Striæ 9 in 0.01 mm. Common. Reported from Kizaki and Biwa Lakes.

GOMPHONEMA CONSTRICTUM Ehr. var. CAPITATA (Ehr.) Cleve.

Gomphonema constrictum Ehr. var. *capitata* (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 377, fig. 715.

Valve clavate, constricted, with broad capitate apex. Length, 0.037 mm; breadth, 0.012. Common. Reported from Kizaki and Biwa Lakes.

GOMPHONEMA VASTUM Hust. var. MAXIMA Skvortzow. Plate 1, fig. 6.

Gomphonema vastum Hust. var. *maxima* SKVORTZOW, Diatoms Biwa Lake (1936) pl. 8, fig. 7.

Valve narrow, lanceolate, gradually attenuate towards the subacute ends. Length, 0.047 mm; breadth, 0.006. Striæ 15 in 0.01 mm, marginate, radiate at the ends, with a distinct isolated punctum. Common. The specimens from Ikeda Lake are smaller than the type from Biwa.

GOMPHONEMA GLOBIFERUM Meister. Plate 1, fig. 1.

Gomphonema globiferum MEISTER, Beiträge zur Bacillar. Japans (1914) 212, pl. 4, fig. 13.

Valve subtruncate, narrow-lanceolate, gradually tapering from the middle to the ends. Apex broad-capitate, base subacute. Striæ slightly radiate, 12 in 0.01 mm. Median punctum distinct. Not common. Known from Suwa Lake, Nippon.

GOMPHONEMA IKEDA sp. nov. Plate 4, fig. 2.

Valve slightly clavate, linear-lanceolate, gradually attenuate towards the subacute ends. Apex with a distinct band. Length, 0.062 mm; breadth, 0.0068. Striæ slightly radiate, 6 in the middle, 12 in 0.01 mm at the ends. Central area unilateral and the isolated punctum distinct. Common. Differs from *G. bohemicum* in its greater length and in the presence of the band in the upper part of the valve.

GOMPHONEMA PUIGGARIANUM Grun. Plate 3, fig. 11.

Gomphonema Puiggarianum Grun., VAN HEURCK, Synopsis (1884–1885) pl. 25, fig. 18.

Valve clavate, attenuate towards the ends. Upper part broad, lower part narrow. Length, 0.042 mm; breadth, 0.006. Striæ marginate, parallel, 10 to 11 in 0.01 mm. Axial and central areas broad without isolated punctum. Differs from the type in its size and the number of striæ, from *G. Lioense* Skv. in its marginal striæ.

EPITHEMIA ARGUS Kütz. var. ALPESTRIS W. Sm. Plate 3, fig. 7.

Epithemia argus Kutz. var. *alpestris* W. Sm., A. SCHMIDT, Atlas Diatom. (1904) pl. 251, figs. 2, 3, 9.

Valve lunate and obtuse. Length, 0.021 mm; breadth, 0.007. Striæ 12 in 0.01 mm. Known from fresh water.

EPITHEMIA ZEBRA (Ehr.) Kütz.

Epithemia zebra (Ehr.) Kütz., FR. HUSTEDT, Bacillar. (1930) 384–385, fig. 729a, b.

Valve lunate, attenuate towards the obtuse ends. Length, 0.076 mm; breadth, 0.013. Very common. Known from Kizaki Lake.

EPITHEMIA ZEBRA (Ehr.) Kütz. var. PORCELLUS (Kütz.) Grun.

Epithemia zebra (Ehr.) Kutz. var. *porcellus* (Kütz.) Grun., FR. HUSTEDT, Bacillar. (1930) 385, fig. 731.

Differs from the type in its subcapitate ends. Length, 0.064 mm; breadth, 0.003. Not common. Known from Biwa Lake.

EPITHEMIA SOREX Kütz.

Epithemia sorex Kütz., FR. HUSTEDT, Bacillar. (1930) 388, fig. 736.

Valve boat-shaped with arcuate dorsal side and rostrate-truncate ends. Length, 0.03 mm; breadth, 0.007. Common. Known from Kizaki and Biwa Lakes.

RHOPALODIA PARALLELA (Grun.) O. Müll. Plate 3, fig. 1.

Rhopalodia parallela (Grun.) O. Müll., FR. HUSTEDT, Bacillar. (1930) 389, fig. 739.

Valve linear, slightly narrow lanceolate with almost parallel margins. Length, 0.085 to 0.105 mm; breadth, 0.017 to 0.025. Striæ 5 in 0.01 mm. Common. An alpine species, reported from Kizaki and Biwa Lakes.

RHOPALODIA GIBBA (Ehr.) O. Müll.

Rhopalodia gibba (Ehr.) O. Müll., Fr. Hustedt, Bacillar. (1930) 390, fig. 740.

Valve linear, arcuate on the dorsal side, straight on the ventral side, reflexed at the extremities. Length, 0.085 to 0.29 mm. Common. Reported from Kizaki and Biwa Lakes.

RHOPALODIA GIBBERULA (Ehr.) O. Müll. var. VAN HEURCKI O. Müll. Plate 1, fig. 24.

Rhopalodia gibberula (Ehr.) O. Müll. var. *Van Heurcki* O. Müll., A. Schmidt, Atlas Diatom. (1904) pl. 255, fig. 21; pl. 265, fig. 14.

Valve lunate, arcuate on the dorsal side, parallel on the ventral side. Length, 0.034 mm; breadth, 0.007. Striæ 18 in 0.01 mm. Common. A brackish-water diatom.

HANTZSCHIA AMPHIOXYS (Ehr.) Grun.

Hantzschia amphioxys (Ehr.) Grun., Fr. Hustedt, Bacillar. (1930) 394, fig. 747.

Valve linear-lanceolate, with abruptly attenuate and subrostrate ends. Length, 0.054 mm; breadth, 0.0068. Common. Reported from Kizaki and Biwa Lakes.

HANTZSCHIA AMPHIOXYS (Ehr.) Grun. var. VIVAX (Hantzsch) Grun. Plate 2, fig. 1.

Hantzschia amphioxys (Ehr.) Grun. var. *vivax* (Hantzsch) Grun., Fr. Hustedt, Bacillar. (1930) 394, fig. 750.

Differs from the type in its longer lanceolate valve, tapering from the middle to the subacute ends. Length, 0.102 mm; breadth, 0.0085. Costæ 7, striæ 18, in 0.01 mm. Not common.

NITZSCHIA TRYBLIONELLA Hantz. var. DEBILIS (Arnott) A. Mayer.

Nitzschia tryblionella Hantz. var. *debilis* (Arnott) A. Mayer, Fr. Hustedt, Bacillar. (1930) 400, fig. 759.

Valve broad-elliptic with cuneate ends. Length, 0.02 mm; breadth, 0.0085. Costæ 15 in 0.01 mm. Common. Reported from Biwa Lake. Known from brackish water.

NITZSCHIA TRYBLIONELLA Hantz. var. VICTORIÆ Grun. Plate 2, fig. 11.

Nitzschia tryblionella Hantz. var. *Victoriæ* Grun., Fr. Hustedt, Bacillar. (1930) 399, fig. 758.

Valve broad-elliptic, constricted in the middle part. Length, 0.059 mm; breadth, 0.028. Costæ 5 to 6 in 0.01 mm. Common. A brackish-water diatom. Known from Biwa Lake.

NITZSCHIA DISSIPATA (Kütz.) Grun.

Nitzschia dissipata (Kütz.) Grun., A. Schmidt, Atlas Diatom. (1921) pl. 332, fig. 23.

Valve narrow-lanceolate, with long capitate ends. Length, 0.045 mm; breadth, 0.005. Costæ 6 to 7 in 0.01 mm. Striæ indistinct. Common. Reported from Kizaki Lake.

NITZSCHIA AMPHIBIA Grun. Plate 1, fig. 31.

Nitzschia amphibia Grun., FR. HUSTEDT, Bacillar. (1930) 414, fig. 793.

Valve lanceolate, with subacute ends. Length, 0.013 mm; breadth, 0.0034. Common.

NITZSCHIA DENTICULA Grun. Plate 1, fig. 13.

Nitzschia denticula Grun., FR. HUSTEDT, Bacillar. (1930) 407, fig. 780.

Valve lanceolate, with subacute ends. Length, 0.028 mm; breadth, 0.006. Costæ very distinct, 5 in 0.01 mm. Striæ punctate, 15 in 0.01 mm. Common.

NITZSCHIA HEIDENI Meister.

Nitzschia Heideni Meister, A. SCHMIDT, Atlas Diatom. (1924) pl. 351, fig. 11.

Valve broad-lanceolate, with long, subacute ends. Length, 0.013 mm; breadth, 0.0025. Costæ very distinct, long, length about one-half the valve breadth. Common. Known from Tokyo, Nippon.

NITZSCHIA OBTUSA W. Smith var. **SCALPELLIFORMIS** Grun. Plate 4, fig. 2.

Nitzschia obtusa W. Smith var. *scalpelliformis* Grun., FR. HUSTEDT, Bacillar. (1930) 422, fig. 817d.

Valve linear-lanceolate and slightly sigmoid. Length, 0.035 mm; breadth, 0.0034. Costæ 6 in 0.01 mm. Not common. A brackish-water diatom.

NITZSCHIA ACUTA Hantzsch.

Nitzschia acuta Hantzsch., FR. HUSTEDT, Bacillar. (1930) 412, fig. 790.

Valve narrow, linear-lanceolate, gradually attenuate towards the subcapitate ends. Length, 0.136 mm; breadth, 0.005. Costæ 6 in 0.01 mm. Common. Known from Kizaki and Biwa Lakes.

NITZSCHIA FRUSTULUM (Kütz.) Grun. var. **PERPUSILLA** (Rabh.) Grun. Plate 1, fig. 12.

Nitzschia frustulum (Kütz.) Grun. var. *perpusilla* (Rabh.) Grun., VAN HEURCK, Synopsis (1884–1885) pl. 99, fig. 6.

Valve lanceolate with cuneate ends. Length, 0.017 mm; breadth, 0.0034. Costæ 12, striæ 24, in 0.01 mm. Not common. Known from brackish water.

NITZSCHIA OKAMURÆ sp. nov. Plate 2, fig. 6.

Valve sublinear or narrow-lanceolate, gradually attenuate towards the subacute end. Length, 0.061 mm; breadth, 0.005. Costæ 6 to 7 in 0.01 mm. Striæ indistinct. This new species is intimately connected with *N. gandersheimiensis* Krasske.

CYMATOPLEURA SOLEA (Bréb.) W. Smith.

Cymatopleura solea (Bréb.) W. Smith, FR. HUSTEDT, Bacillar. (1930) 425, fig. 823a.

Valve linear, constricted in the middle part. Ends cuneate Not common. Known from Biwa Lake.

SURIRELLA ROBUSTA Ehr.

Surirella robusta Ehr., FR. HUSTEDT, Bacillar (1930) 437, fig. 850.

Valve elongate-ovate, one end much broader than the other. Length, 0.195 mm; breadth, 0.085. Costæ robust, radiate at the ends. Pseudoraphe lanceolate. Common. Reported from Kizaki Lake

SURIRELLA ROBUSTA Ehr. fo. LATA Hust.

Surirella robusta Ehr. fo. *lata* FR. HUSTEDT, Bacillar. aus dem Aokikosee in Japan 169-170, fig. 1

This form differs from the type in its broader valves. Length, 0.165 mm; breadth, 0.085. Common. Reported from Kizaki and Aokiko Lakes.

SURIRELLA ROBUSTA Ehr. var. SPLENDIDA (Ehr.) Van Heurck.

Surirella robusta Ehr. var. *splendida* (Ehr.) Van Heurck, FR. HUSTEDT, Bacillar. (1930) 437, figs. 851–852

Like the type, but with coarser costæ. Length, 0.144 mm; breadth, 0.051 Common Reported from Kizaki and Biwa Lakes.

SURIRELLA ROBUSTA Ehr. var. SPLENDIDA (Ehr.) Van Heurck fo. NIPPONICA fo. nov. Plate 1, fig. 5.

Valve elongate ovate, rounded at one end and acute at the other Length, 0.141 mm; breadth, 0.037. Costæ 2 in 0.01 mm, with intercostal striæ 18 in 0.01 mm. Pseudoraphe lanceolate narrow, with distinct little spines. Not common.

SURIRELLA ROBUSTA Ehr. var. OKAMURÆ var. nov. Plate 1, fig. 6.

Valve rhomboidal-elliptic, with acute ends. One end much broader than the other. Length, 0.09 mm, breadth, 0.034. Costæ 1.5 in 0.01 mm. Marginal alæ robust, outer rim distinct. Not common. This is a distinct variety akin to forma *Hustedtiana* (Mayer) Hust.

SURIRELLA LINEARIS W. Smith.

Surirella linearis W. Smith, FR. HUSTEDT, Bacillar. (1930) 434, figs. 837, 838.

Valve linear-lanceolate with margins parallel in the middle, gradually attenuate towards the cuneate ends. Length, 0.068

mm; breadth, 0.012. Costæ reaching the pseudoraphe. Common. Known from Kizaki Lake.

SURIRELLA LINEARIS W. Smith var. HELVETICA (Brun) Meister.

Surirella linearis W. Smith var. *helvetica* (Brun) Meister, FR. HUSTEDT, Bacillar. (1930) 434, fig. 840.

Valve linear, cuneate. Length, 0.115 to 0.127 mm; breadth, 0.028 to 0.03. Costæ 20 in 0.01 mm. Pseudoraphe distinct and punctate. Common. Known from Kizaki Lake.

SURIRELLA BISERIATA Breb.

Surirella biseriata Breb. FR. HUSTEDT, Bacillar. (1930) 432 figs. 831 832.

Valve lanceolate with parallel margins and acuminate ends. Length, 0.093 mm; breadth 0.019. Costæ distinct, dilated at the margins, radiate at the ends. Not common. Reported from Kizaki and Biwa Lakes.

SURIRELLA BISERIATA Breb. var. CONSTRICTA Grun.

Surirella biseriata Breb. var. *constricta* Grun. FR. HUSTEDT, Bacillar (1930) 433, fig. 835.

Valve constricted. Length, 0.098 mm, breadth, 0.02. Common. Known from Kizaki Lake.

SURIRELLA BISERIATA Breb. var. BIFRONS (Ehr.) Hust fo. HISPIDA Skvortzow.

Surirella biseriata Breb. var. *bifrons* (Ehr.) Hust. fo. *hispida* SKVORTZOW, Diatoms Kizaki Lake (1936) pl. 15, fig. 1.

Valve elliptic-lanceolate, broad, with acute ends. Length, 0.061 mm; breadth, 0.021. Pseudoraphe with distinct horns. Not common. Reported from Kizaki Lake.

SURIRELLA ELEGANS Ehr.

Surirella elegans Ehr., FR. HUSTEDT, Bacillar (1930) 440, figs. 858, 859.

Valve elongate-ovate. One end much broader than the other. Length, 0.24 mm; breadth, 0.068. Costæ dilated at the margin, attenuate towards the pseudoraphe, 20 in 0.01 mm. Not common. Reported from Biwa Lake.

SURIRELLA ELEGANS Ehr. var. NORVEGICA (Eulenst.) Brun. Plate 3, fig. 1

Surirella elegans Ehr. var. *norvegica* (Eulenst.) Brun, A. MAYER, Bacillar. d. Regensburger Gewässer (1912) 343, 344 pl. 23, fig. 1.

Larger and longer than the type. Length, 0.357 mm, breadth, 0.06. Costæ 10 in 0.01 mm, with intercostal striæ more or less evident. Striæ 20 to 25 in 0.01 mm. Common. Reported from Biwa Lake.

SURIRELLA TENUIS Mayer var. NIPPONICA var. nov. Plate 1, fig. 6.

Valve elongate-ovate, rounded at one end and acute at the other. Length, 0.032 mm; breadth, 0.0085. Costæ short or marginal, 40 in 0.01 mm. Differs from the type in its short and broad valves. Not common.

SURIRELLA TERRYANA Ward.

Surirella Terryana Ward, A. SCHMIDT, Atlas Diatom. (1912) pl. 280, figs. 7, 8.

Valve linear, with obtuse ends, parallel or slightly constricted margins. Length, 0.111 mm; breadth, 0.017. Common. Known from Kizaki and Aokiko Lakes.

SURIRELLA NIPPONICA Skvortzow.

Surirella nipponica SKVORTZOW, Diatoms Kizaki Lake (1936) pl. 6, fig. 17.

Valve lanceolate, with attenuate ends. Length, 0.056 mm; breadth, 0.016. Costæ short, radiate, about 40 in 0.01 mm. Common. Reported from Kizaki and Biwa Lakes

SURIRELLA OKAMURÆ sp. nov. Plate 2, figs. 10, 12, and 13.

Valve linear-elliptic, constricted on both sides and subrostrate at the ends. Length, 0.095 to 0.102 mm; breadth, 0.017 to 0.018. Central area linear. Costæ reaching the pseudoraphe, 6 to 7 in 0.01 mm. Outer rim distinct. A species related to *S. biwensis* Skv., from Biwa Lake, and *S. Heidenii* Hust., from Tanganyika Lake, but not to *Cymatopleura solea* (Breb.) S. Smith.

ILLUSTRATIONS

PLATE 1

FIG. 1. *Gomphonema globiferum* Meister.
2. *Navicula pupula* Kütz. var. *elliptica* Hust.
3. *Diploneis ovalis* (Hilse) Cleve.
4. *Gyrosigma Kützingii* (Grun.) Cleve.
5. *Cymbella alpina* Grun. fo. *nipponica* fo. nov.
6. *Synedra rumpens* Kütz. var. *Meneghiniana* Grun.
7. *Epithemia argus* Kütz. var. *alpestris* W. Smith.
8. *Gomphonema vastum* Hust. var. *maxima* Skv.
9. *Cymbella leptoceros* (Ehr.) Grun.
10. *Navicula Ikari* Skv. var. *nipponica* var. nov.
11. *Mastogloia elliptica* Agardh var. *dansei* (Thwaites) Grun.
12. *Navicula subtilissima* Cleve var. *Okamuræ* var. nov.
13. *Navicula tuscula* (Ehr.) Grun.
14. *Achnanthes linearis* W. Smith var. *nipponica* var. nov.
15. *Nitzschia denticula* Grun.
16. *Navicula hasta* Pant. fo. *minor* fo. nov.

FIGS. 17 and 18. *Navicula ventralis* Krasske var. *Okamuræ* var. nov.

FIG. 19. *Navicula atomarius* Skv.
20. *Achnanthes linearis* W. Smith var. *nipponica* var. nov.
21. *Navicula hungarica* Grun. var. *capitata* (Ehr.) Cleve.
22. *Navicula falaisiensis* Grun. var. *lanceola* Grun.
23. *Navicula minima* Grun. var. *Okamuræ* var. nov.
24. *Cymbella turgidula* Grun.
25. *Achnanthes Okamuræ* sp. nov.
26. *Rhopalodia gibberula* (Ehr.) O. Müll. var. *Van Heurcki* O. Müll.
27. *Gomphonema augur* Ehr. var. *Gautieri* Van Heurck.
28. *Nitzschia frustulum* (Kütz.) Grun. var. *perpusilla* (Rabh.) Grun.
29. *Diploneis puella* (Schum.) Cleve.
30. *Cymbella turgida* (Greg.) Cleve fo. *minor* fo. nov.
31. *Nitzschia amphibia* Grun.
32. *Amphora normani* Rabh.

PLATE 2

FIG. 1. *Neidium affine* (Ehr.) Cleve var. *amphirhynchus* (Ehr.) Cleve.
2. *Anomoeoneis exilis* (Kütz.) Cleve var. *lanceolata* A. Mayer.
3. *Amphipleura pellucida* Kutz. var. *recta* Kitton.
4. *Gyrosigma acuminatum* (Kütz.) Rabh.
5. *Pinnularia borealis* Ehr.
6. *Pinnularia Hustedti* Meister var. *nipponica* var. nov.
7. *Pinnularia gibba* Ehr. var. *Okamuræ* var. nov.
8. *Surirella tenuis* Mayer var. *nipponica* var. nov.
9. *Achnanthes Kizaki* Skv.

FIG. 10. *Surirella Okamuræ* sp. nov.
11. *Nitzschia tryblionella* Hantz. var. *Victoriæ* Grun.
12. *Navicula anglica* Ralfs.
13. *Melosira islandica* O. Müll. subsp. *helvetica* O. Müll.
14. *Frustulia rhomboides* (Ehr.) de Toni var. *saxonica* (Rabh.) de Toni fo. *capitata* A. Mayer.
15. *Navicula lanceolata* (Agardh) Kütz.
16. *Neidium dubium* (Ehr.) Cleve fo. *constricta* Hust.
17. *Pinnularia borealis* Ehr.

FIGS. 18 and 19. *Surirella Okamuræ* sp. nov.

PLATE 3

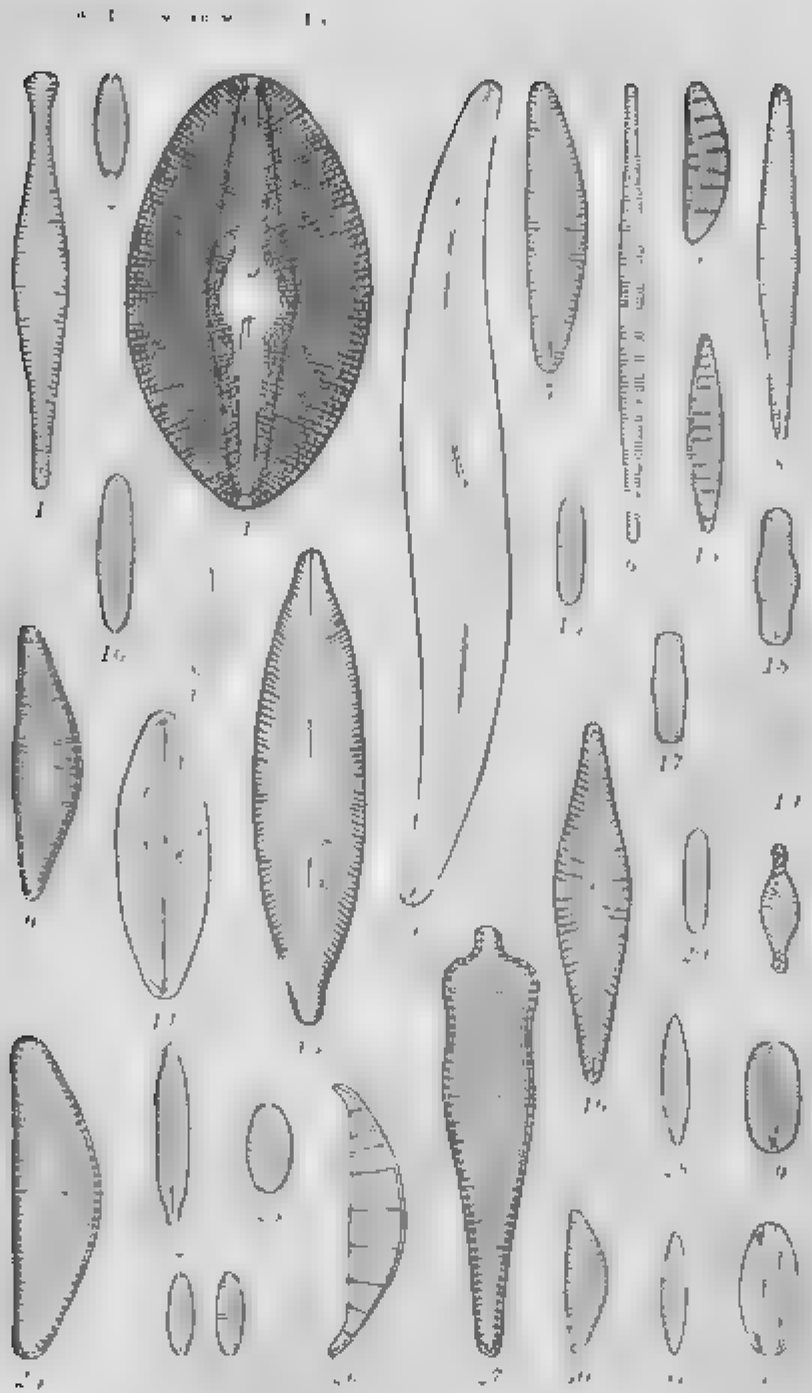
FIG. 1. *Surirella elegans* Ehr. var. *norvegica* (Eulenst.) Brun.
2. *Rhopalodia parallela* (Grun.) Müll.
3. *Hantzschia amphioxys* (Ehr.) Grun. var. *vivax* (Hantzsch) Grun.
4. *Pinnularia kiusiuensis* sp. nov.
5. *Gyrosigma Spenceri* (W. Smith) Cleve var. *Okamuræ* var. nov.
6. *Surirella robusta* Ehr. var. *Okamuræ* var. nov.
7. *Gomphonema ventricosum* Kütz.
8. *Eunotia flexuosa* Kütz.
9. *Nitzschia Okamuræ* sp. nov.
10. *Gyrosigma Spenceri* (W. Smith) Cleve var. *Okamuræ* var. nov.
11. *Pinnularia microstauron* (Ehr.) Cleve.
12. *Synedra amphicephala* Kütz.
13. *Gomphonema puiggarianum* Grun.

PLATE 4

FIG. 1. *Cymbella aspera* (Ehr.) Cleve.
2. *Nitzschia obtusa* W. Smith var. *scalpelliformis* Grun.
3. *Surirella robusta* Ehr. var. *splendida* (Ehr.) Van Heurck fo. *nipponica* fo. nov.
4. *Neidium iridis* (Ehr.) Cleve var. *amphigomphus* (Ehr.) Van Heurck fo. *angusta* fo. nov.
5. *Navicula halophila* (Grun.) Cleve var. *Okamuræ* var. nov.
6. *Eunotia tenella* (Grun.) Hust.
7. *Gomphonema Ikedæ* sp. nov.
8. *Pinnularia lignitica* Cleve.
9. *Navicula cuspidata* Kütz.

FIGS. 10 and 11. *Synedra rumpens* Kütz. var. *Okamuræ* var. nov.

FIG. 12. *Frustulia rhomboides* (Ehr.) de Toni var. *amphipleuroides* Grun.
13. *Gomphonema augur* Ehr. var. *Okamuræ* var. nov.



PLATE

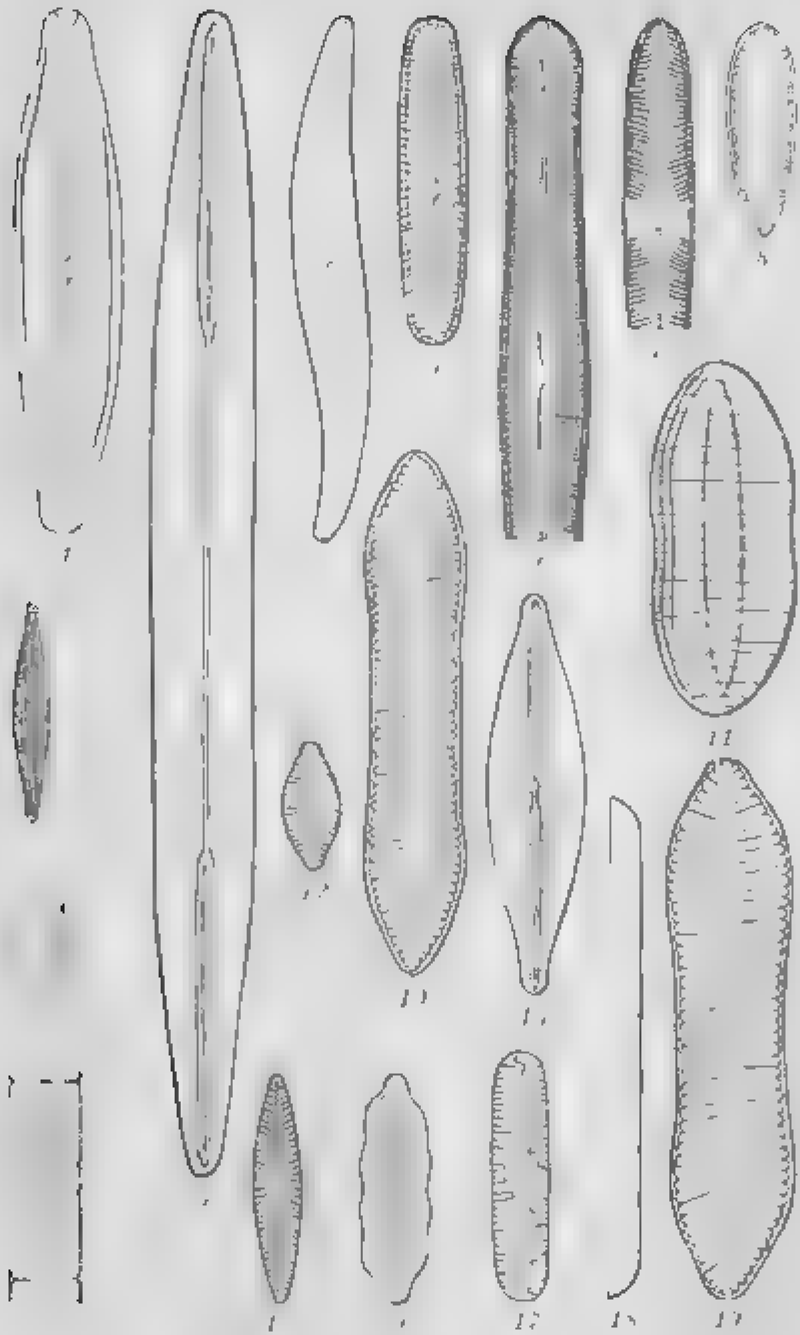
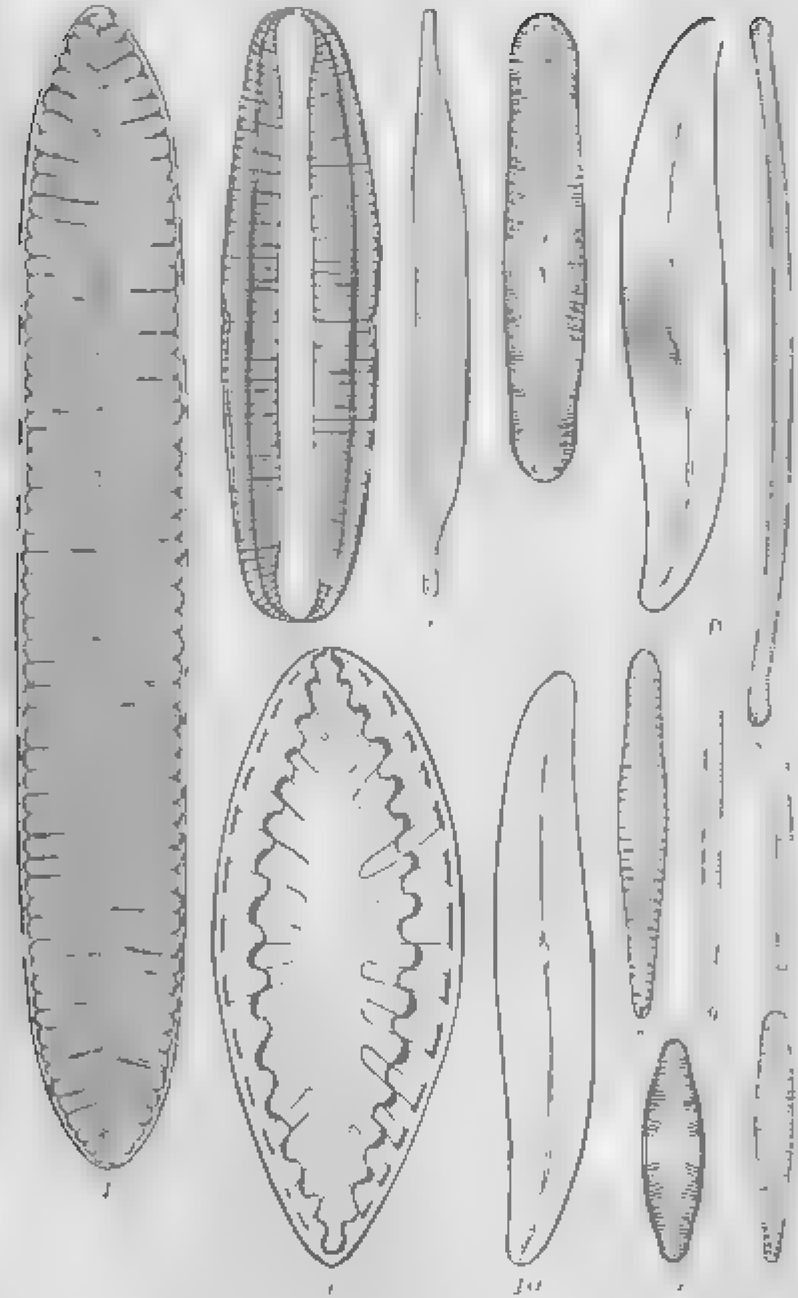


PLATE 2



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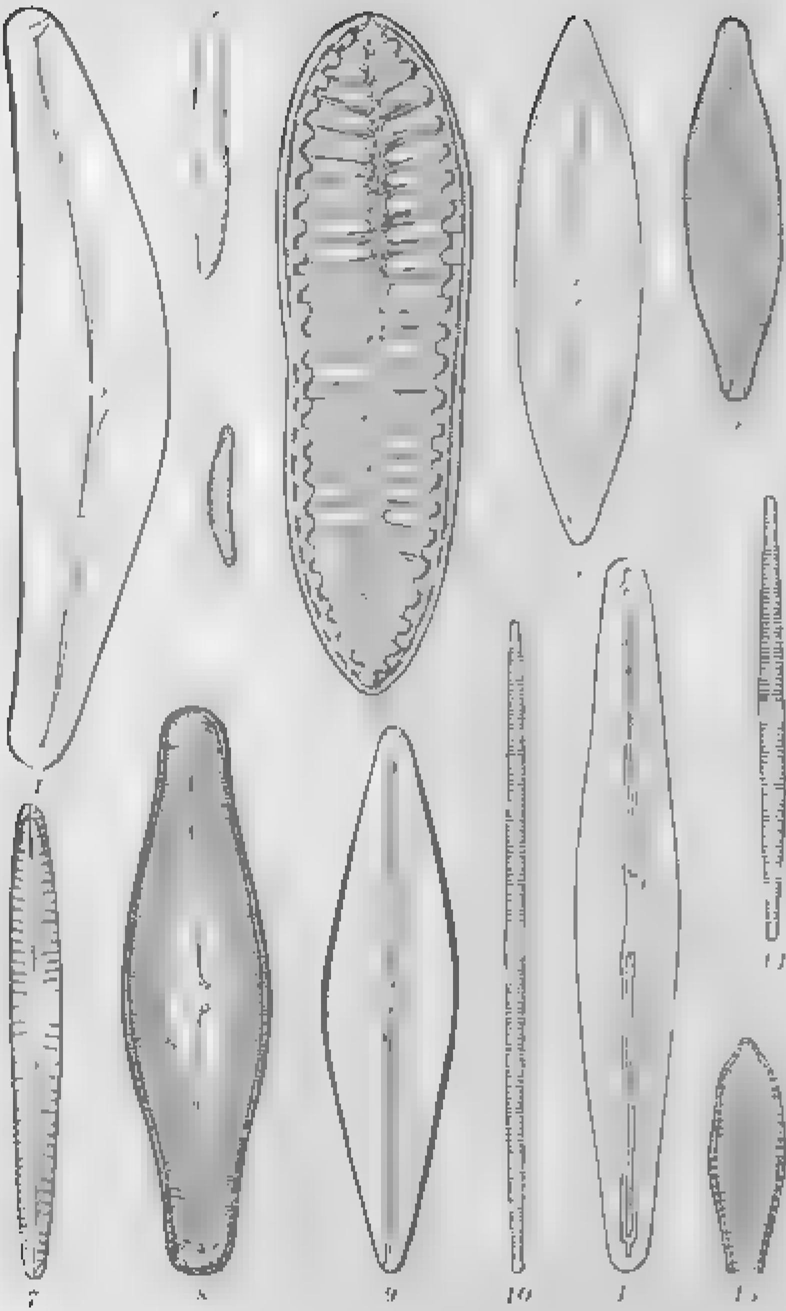

PLATE 4.

FIVE SPECIES OF PHILIPPINE SHRIMPS OF THE GENUS PENÆUS

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THREE PLATES

This paper presents a systematic study of five commercial species of shrimps locally known as *hipon, pasayan,* and *sugpô* (Tagalog), *padao* or *pasayan* (Ilocano); and *locon* or *balusugay* (Visayan).

The commercial possibilities of the shrimp fisheries of the Philippines are still undetermined. The fresh shrimps found in the local markets are supplied mostly from the catches of the beam trawls in Manila Bay, Lingayen Gulf, and Malampaya Sound, and from fishponds in various parts of the Philippines. Shrimps are also caught in fish corrals.

The amount of fresh shrimps landed at Manila from January to November, 1934, was 322,818 kilograms, a monthly average of 35,868.66 kilograms. The estimated value of the shrimps is 129,127.20 pesos[1] for the year, an average of 14,347 pesos per month. In 1935 the amount was 494,182 kilograms, a monthly average of 41,181 kilograms. The estimated value of the shrimps caught in 1935 is 177,672.80 pesos, a monthly average of 14,806 pesos. These shrimps come from Manila Bay, Lingayen Gulf, Malampaya Sound, and Ragay Gulf. Table 1 shows the amount of fresh shrimps landed in Manila during 1934 and 1935. The total value of the fresh shrimps caught in the Philippines even for the last two years is still undetermined.

The shrimp industry in the Philippines has great commercial possibilities, and its development deserves serious study. More fishing grounds for shrimps should be located along the shores, bays, and estuaries, and better methods of catching these crustaceans should be introduced. Nets of larger capacity, 100 to 500 feet in length, should be used to bring in commercial catches.

[1] One peso Philippine currency equals 50 cents United States currency.

TABLE 1.—*Weight in kilograms of fresh shrimps landed at Manila during 1934 and 1935.*

Month.	1934 Kg.	1935 Kg.
January	24,651	24,060
February	28,710	29,926
March	40,240	30,459
April	31,176	32,091
May	35,642	35,149
June	4,255	30,459
July	31,393	37,811
August	35,746	44,047
September	33,229	53,140
October	32,443	62,319
November	25,231	53,847
December	------	61,065
Total	322,812	494,182

At present five common and important species are found in the commercial catches of shrimps; namely, *Penæus canaliculatus* Olivier, *P. affinis* Milne-Edwards, *P. incisipes* Bate, *P. indicus* Milne-Edwards, and *P. monodon* Fabricius.

PENEIDÆ

Rostrum well developed, laterally compressed, sometimes short and elevated, often toothed, rostral lateral sulci long or short and deeply grooved. Antennules with two flagella; basal joint of peduncle dorsally concave for eye. Mandible with incisor process, with palp of one or two segments. First three pairs of legs similar, chelate, and slender; last two pairs well developed.

Genus PENÆUS Fabricius

Rostrum toothed above and below or fringed with hairs inferiorly. Outer edge of basal joint of antennular peduncle produced into anterior spine; antennular flagella shorter than carapace. Mandibular palp large and foliaceous, 2-jointed, second segment larger than first. Exopodites on first to fourth leg. Dorsal surface of three abdominal somites with keellike ridge. First, second, and third legs with pincers.

Key to the five species of Penæus in the Philippines.

a.[1] Lateral rostral sulci extending to posterior margin of carapace; rostral formula $\frac{11-12}{1}$, lower and last upper anterior tooth opposite.

P. canaliculatus.

a.[2] Lateral rostral sulci not extending to posterior margin of carapace.

b.[1] Rostrum with no crest; ventral margin fringed with hairs, no teeth.

c.[1] Rostral formula $\frac{9-11}{0}$; slightly turned upward on tip; usually the first two teeth on carapace .... *P. affinis.*

c.[2] Rostral formula $\frac{8-11}{0}$, rostrum narrow, straight; carapace rough. *P. incisipes.*

b.[2] Rostrum with crest, ventral margin with 3 to 6 teeth.

c.[1] Rostral formula $\frac{7-8}{4-5}$, rostrum broadly arched, abruptly thinned tapering anteriorly .... *P. indicus.*

c.[2] Rostral formula $\frac{6-7}{3}$, rostrum straight, laterally compressed. *P. monodon.*

PENÆUS CANALICULATUS Olivier. Plate 1, figs. 1 to 7.

Penæus canaliculatus OLIVIER, Encyc. Method 8 (1811) 660 [a]; MILNE-EDWARDS, Hist. Nat. Crust. 2 (1837) 414; BATE, Crustacea Macrura Challenger Zoo. 24 (1873-1876) 243-245, pl. 32, figs. 1, 2, Ann. & Mag. Nat. Hist. V 8 (1881) 174-175.

Rostrum straight, slightly elevated, reaching just beyond the tip of antennular peduncle; rostral formula $\frac{11-12}{1}$; 11 to 12 teeth on the upper margin of rostrum, 4 or 5 on the carapace; inferior margin with one tooth, below the last anterior tooth of the upper margin. Lateral rostral sulci extending on nearly entire length of posterior margin of carapace. Last three pleural somites compressed and dorsally keeled. Telson without spines, apex acuminate, fringed with hairs at the sides, dorsal median line grooved to the apex.

TABLE 2.—*Length and rostral formula of Penæus canaliculatus Olivier, all from Bantayan, Bantayan Island, Cebu Province, January 1, 1939.*

Serial No.	Sex.	Length.	Rostral formula.	Serial No.	Sex.	Length.	Rostral formula.
		cm.				cm.	
1	♀	10.8	$\frac{11}{1}$	6	♀	9.6	$\frac{12}{1}$
2	♀	10.7	$\frac{11}{1}$	7	♀	9.1	$\frac{12}{1}$
3	♀	11.2	$\frac{12}{1}$	8	♀	10.5	$\frac{11}{1}$
4	♀	8.7	$\frac{11}{1}$	9	♂	11.6	$\frac{11}{1}$
5	♀	12.5	$\frac{12}{1}$	10	♀	9.0	$\frac{12}{1}$

[a] Not in the Scientific Library, Philippine Bureau of Science, Manila.

Ten specimens, 9.1 to 12.5 cm long (Table 2).

BANTAYAN ISLAND, Cebu Province, Bantayan, January 1, 1929.

PENAEUS AFFINIS Milne-Edwards. Plate 1, fig. 4.

Penaeus affinis MILNE-EDWARDS, Hist. Nat. Crust. 2 (1837) 416; BATE, Ann. Mag. Nat. Hist. V 8 (1881) 170, pl. 12, fig. 6; ORTMANN, Zool. Jahrb. Syst. 5 (1890) 460; HENDERSON, Trans. Linn. Soc. 2d ser. Zool. 5 (1893) 448; KISHINOUYE, Journ. Fish. Bur. 8 (1900) 16, pl. 7, fig. 5, 5a; NOBILI, Boll. Mus. Torino 22 (1903) 2.[1]

Metapenaeus affinis ALCOCK, Indian Mus. Macrura pt. 3 (1906) 20-21, pl. 3, figs. 8, 8a, b.

Rostrum slender, no crest, slightly turned upwards at the extremity; rostral formula $\frac{9-11}{0}$; 9 to 11 teeth on upper border of rostrum, 2 teeth always on the carapace; inferior margin without a tooth, instead fringed with hairs. First pair of antennal peduncle on level with the tip of the rostrum. Flagella of second pair of antennæ $4\frac{1}{2}$ times as long as body. Lateral rostral sulci on the level of the last posterior tooth on the carapace. Thelycum setose; its lateral lobes flattish and transversely cut into two unequal parts. Last pair of thoracic legs in both sexes longer than the tip of the antennal scale by the length of the dactylus. Telson shorter than internal plate of uropod.

TABLE 3.—*Length and rostral formula of Penaeus affinis Milne-Edwards*

Serial No.	Sex.	Length.	Rostral formula.	Locality.
		cm.		
1	♀	10	$\frac{9}{0}$	Luzon, Ilocos Norte Province, Cassecpa River Laoag, August 17 1932.
2	♀	[illegible]	$\frac{9}{0}$	Do.
3	♀	10.2	$\frac{10}{0}$	Luzon, Cagayan Province, Aparri, May 22, 1932.
4	♀	10.5	$\frac{9}{0}$	Do.
5	♀	10	$\frac{10}{0}$	Do.
6	♀	9.2	$\frac{10}{0}$	Manila, Paco market, Ap.il 1931.
7	♀	[illegible]	$\frac{9}{0}$	Do.
8	♂	8.5	$\frac{10}{0}$	Luzon, Camarines Sur Province, San Miguel Bay, September 25, 1924.
9	♂	6.4	$\frac{10}{0}$	Luzon, Bicol Provinces, Lagy, November 19, 1926.
10	♂	10.0	$\frac{10}{0}$	Do.
11	♂	9	$\frac{11}{0}$	Do.

[1] See footnote 2.

Eleven specimens, 6.4 to 10.9 cm long (Table 3).

LUZON, Ilocos Norte Province, Caaoacan River, Laoag, August 17, 1933; Cagayan Province, Aparri, May 22, 1923; Manila, Paco market, April 1, 1931; Camarines Sur Province, San Miguel Bay, September 25, 1924; Bicol Provinces, Locy, November 19, 1926.

PENAEUS INCISIPES Bate. Plate 3, fig. 5.

Penaeus incisipes BATE, Crustacea Macrura, Challenger Zool. 24 (1873–1876) 257–258, pl. 34, fig. 2.

Rostrum narrow, straight, slightly elevated. Rostral formula $\frac{8\text{–}11}{0}$; 8 to 11 teeth on the upper margin of rostrum, 2 teeth on the carapace, inferior margin fringed with hairs, carapace rough. Lateral rostral sulci terminating on level with the last posterior teeth on the carapace. Flagella of first pair of antennæ as long as the peduncle, flagella of the second pair of antennæ three times as long as the body. Chelæ long and slender, dactylus flattened, merus notched under. Petasma on the first pair of pleopod in male, long, narrow, and double-headed on extremity. Telson shorter than the plates of the uropod.

TABLE 4.—*Length and rostral formula of female Penaeus incisipes Bate, all from Limay, Bataan Province, Luzon.*

Serial No.	Length	Rostral formula	Serial No.	Length	Rostral formula	Serial No.	Length	Rostral formula
	cm.			cm.			cm.	
1	11.9	$\frac{10}{0}$	9	7.3	$\frac{10}{0}$	17	13.2	$\frac{10}{0}$
2	11	$\frac{10}{0}$	10	8.9	$\frac{10}{0}$	18	12.4	$\frac{9}{0}$
3	9.9	$\frac{9}{0}$	11	8.8	$\frac{9}{0}$	19	13.9	$\frac{8}{0}$
4	11.2	$\frac{8}{0}$	12	9.6	$\frac{10}{0}$	20	11.5	$\frac{10}{0}$
5	11	$\frac{9}{0}$	13	8.6	$\frac{10}{0}$	21	12.6	$\frac{11}{0}$
6	10.3	$\frac{9}{0}$	14	7.7	$\frac{9}{0}$	22	12	$\frac{9}{0}$
7	8.8	$\frac{9}{0}$	15	13.3	$\frac{10}{0}$	23	10.8	$\frac{9}{0}$
8	8.8	$\frac{10}{0}$	16	14.9	$\frac{9}{0}$	24	12.1	$\frac{10}{0}$

Twenty-four female specimens, 7.3 to 14.9 cm long (Table 4).

LUZON, Bataan Province, Limay, November 22, 1934.

PENAEUS INDICUS Milne-Edwards. Plate 2, figs. 6 and 7.

Penaeus indicus MILNE-EDWARDS, Hist. Nat. Crust. 2 (1837) 415; BATE, Ann. and Mag. Nat. Hist. V 8 (1881) 177, pl. 12, fig. 5; Crustacea Macrura Challenger Zool. 24 (1873–1876) 248–249.

Rostrum straight; rostral crest decreasing gradually towards the posterior margin of the carapace. Rostral formula $\frac{7-8}{4-5}$; 7 to 8 teeth on the upper margin of the rostrum, 3 teeth on the carapace, that of the lower margin of the rostrum with 4 to 5 teeth. Lateral rostral sulci not extending beyond the last posterior teeth. Telson acuminate with a median dorsal longitudinal groove. Outer plates of uropods $1\frac{1}{4}$ times as long as telson.

TABLE 5.—*Length and rostral formula of Penaeus indicus Milne Edwards.*

Serial No.	Sex.	Length.	Rostral formula.	Locality.
		cm.		
1	♀	15.1	$\frac{7}{4}$	Luzon, Manila Bay, November 13, 1934.
2	♀	16.4	$\frac{7}{4}$	Do.
3	♀	16.6	$\frac{7}{4}$	Do.
4	♀	14.2	$\frac{7}{4}$	Do.
5	♂	14.3	$\frac{8}{4}$	Do.
6	♀	14.3	$\frac{8}{4}$	Luzon, Manila, October 12, 1911
7	♀	13.2	$\frac{7}{4}$	Luzon, Bulacan Province, Malolos, September 4, 1927
8	♀	11.3	$\frac{7}{4}$	Luzon, Bulacan Province, Santa Cruz, Paombong, April 22, 1927
9	♀	15.8	$\frac{7}{6}$	Do.
10	♀	13.1	$\frac{7}{4}$	Do.
11	♀	15.4	$\frac{8}{4}$	Do.

Eleven specimens (Table 5).

LUZON, Manila Bay, November 13, 1934, Manila, October 12, 1911; Bulacan Province, Malolos, September 4, 1927; Santa Cruz, Paombong, April 22, 1927.

PENAEUS MONODON Fabricius. Plate 1.

Penaeus monodon FABRICIUS, Ent. Syst. Suppl. (1798) 408; MILNE-EDWARDS, Hist. Nat. Crust. 2 (1837) 416; STIMPSON, Proc. Acad. Sci. Phila. (1860) 44;[4] HELLER, Novara Crust. (1868) 122; BATE, Ann. & Mag. Nat. Hist. V 8 (1881) 178, pl. 11, Challenger Rept. Zool. 24 (1873–1876) 250–252; ALCOCK, Cat. Indian Decapod Crust. Indian Mus. pt. 3 (1906) 9–10, pl. 1.

[4] See footnote 2.

Penaeus semisulcatus DE HAAN, Fauna Japonica de von Siebold Crust. (1850) 191, pl. 46, fig. 1.
Penaeus carinatus DANA, Crustacea U. S. Explor. Exped. pt. 1 13 (1852) 602, pl. 11, fig. 2;[b] WALKER, Journ. Linn. Soc. Zool. 20 (1887) 112.
Penaeus ashiaka KISHINOUYE, Journ. Fish. Bur. 8 (1900) 7, 14, pl. 3; NOBILI, Boll. Mus. Torino 18 (1903) 2.[b]

Rostrum straight, dorsally elevated into a laterally compressed crest. Rostral formula $\frac{6-7}{3}$; 6 to 7 teeth on the upper margin of the rostrum, 3 of them on the carapace; lower edge with 3 teeth. Rostral crest gradually lessens behind the last teeth on the carapace. Lateral rostral sulci on both sides of dorsal crest formed by longitudinal ridge that commences from the apex of the rostrum, and terminates at a line on the level of the posterior tooth of the crest. Antennular scales reach beyond the eyes; outer longer antennular flagellum shorter than its peduncle. Petasma symmetrical, consisting of two opposing

TABLE 6.—*Length and rostral formula of Penaeus monodon Fabricius.*

Serial No.	Sex	Length	Rostral formula.	Locality.
		cm.		
1	♀	14.0	$\frac{7}{3}$	Luzon, Pangasinan Province, Lingayen Gulf, Dagupan, October 8, 1924.
2	♂	10.2	$\frac{7}{3}$	Do.
3		13.0	$\frac{7}{3}$	Luzon, Manila Bay, November 20, 1926.
4	♂	12.1	$\frac{7}{3}$	Do.
5	♂	13.9	$\frac{7}{3}$	Do.
6	♂	11.7	$\frac{7}{3}$	Do.
7	♂	14.4	$\frac{7}{3}$	Do.
8	♀	13.9	$\frac{7}{3}$	Do.
9	♂	12.7	$\frac{7}{3}$	Do.
10	♀	17.2	$\frac{7}{3}$	Luzon, Ilocos Sur Province, Vigan, May 24, 1923.
11	♀	17.0	$\frac{7}{3}$	Do.
12	♀	16.2	$\frac{7}{3}$	Do.

[b] See footnote 2.

simple lobes, forming a tube. The 4th to 6th abdominal somites carinated in the middle line. The lateral borders of the telson without spines.

Twelve specimens of both sexes, 11.7 to 17.2 cm long (Table 6).

LUZON, Pangasinan Province, Lingayen Gulf, Dagupan, October 3, 1934; Manila Bay, November 30, 1934; Ilocos Sur Province, Vigan, May 31, 1923.

ILLUSTRATIONS

(Drawings by Angel D. Lagman.)

Plate 1

Fig. 1. *Penaeus canaliculatus* Olivier, lateral view of head, natural size.

2. *Penaeus canaliculatus* Olivier, dorso-lateral view of telson and uropods, natural size.

3. *Penaeus canaliculatus* Olivier; dorsal view of carapace, natural size.

4. *Penaeus affinis* Milne-Edwards; lateral view of head, natural size.

Plate 2

Fig. 5. *Penaeus incisipes* Bate; lateral view of head, natural size.

6. *Penaeus indicus* Milne-Edwards; lateral view of head, natural size.

7. *Penaeus indicus* Milne-Edwards; dorsal view of telson, natural size.

Plate 3

Penaeus monodon Fabricius; natural size.

PLATE 1.

PLATE 7

PLATE 3

THE ARTIFICIAL FERTILIZATION OF DANGIT, AMPHACANTHUS ORAMIN (BLOCH AND SCHNEIDER)

By Porfirio R. Manacop
Of the Fish and Game Administration, Bureau of Science, Manila

ONE PLATE

Amphacanthus oramin (Bloch and Schneider) is, in some localities of the Philippines, considered an important food fish. It is commonly known as *dangit* in the Visayan Provinces; as *barawis*, *turus*, and *bataoway* in the Bicol Provinces; as *barañgan* or *malaga* in the Ilocano Provinces; and as *samaral* in the Tagalog Provinces. It is caught principally in shallow-water fish corrals. The most important fishing centers of dangit are: Murcielagos Bay, the northern, western, and southwestern parts of Bohol; Bantayan Island, Cebu; the coasts of Sorsogon and Camarines Sur; a number of municipalities in the Ilocos Provinces, and in the Calatagan Peninsula, Batangas Province. Bantayan, Bantayan Island, Cebu, is probably the most important fishing center for dangit in the entire Philippine Archipelago.

The dangit is caught in large quantities during the fishing season, from January to April around Bantayan Island and Murcielagos Bay, and from January to February around Tagbilaran, Bohol. Often the catch is so large that thousands of fish are dried and marketed in a salted state in the neighboring inland towns. The roe and fry (*kuyug*) of dangit are also collected and preserved in a salted state, and are considered a delicacy in the Visayan Islands and the Bicol Provinces. Because of the enormous yearly catches of both the mature and the young, the eventual depletion of this fish in shallow waters is not improbable, due largely to its habit of ovipositing in shallow waters, especially in and around fish corrals, where the eggs are subject to wholesale destruction.

The natural destruction of the eggs apparently is large, since they are laid on the bottom. The principal loss is through thoughtless tramping by the fishermen brailing their catch from the terminal pound (*bunuan*) of the fish corral. The operation

of fine-meshed *sinamay* seines (*baling* and *baling-baling*) on the spawning grounds also causes the destruction of enormous numbers of eggs, which are covered or pressed by the bottom line of these drag seines. Probably some of the eggs are fed upon by numerous animals, including fish. Failure of fertilization of the eggs is another cause of loss.

This paper is a preliminary report on the artificial fertilization of *Amphacanthus oramin*. If artificial propagation of this species proves possible, the eggs can be hatched on a large scale, and the dangit fishery, which has been apparently declining during recent years, maintained and rehabilitated This work was done in Murcielagos Bay during the spawning run of March 28, 1936, and again in Tagbilaran, Bohol, in April of the same year.

SPAWNING

The peak of the spawning activity of the dangit in Murcielagos Bay and in Bantayan, Bantayan Island, Cebu, is from January to April. In Tagbilaran and vicinity, Bohol, however, it occurs during January and February. The dangit spawns at a minimum length of 9 centimeters for the male and 12 centimeters for the female

Spawning takes place from the fourth to the seventh night after the appearance of the new moon in Bantayan, Bantayan Island, Cebu. In Murcielagos Bay and Tagbilaran, Bohol, however, the spawning period usually lasts only for two days, seldom for three, beginning on the fifth day after the new moon. The fish come in large schools to shallow tidal flats as the tide begins to rise, and spawning begins after midnight, when the tide begins to recede, and lasts until dawn.

The dangit appears to pair during the spawning run. The eggs, which are deposited by the females on the bottom, are probably fertilized by the chasing male as he passes over them. The pairing of the fish and the impounding of the school of spawning dangit in the terminal crib, or pound, bring the sexual elements in close proximity, insuring fertilization and consequently a high percentage of hatching.

The dangit is one of the most prolific fishes The number of eggs laid by a 21 4-centimeter female (total length) in a spawning act is estimated at about 419,000 A female of a total length of 16.4 centimeters was found to have spawned at one time about 363,000 ova. This number was approximated by dividing the total weight of a pair of ovaries that had been preserved in 5

per cent formalin by the weight of a known number of eggs taken from a ripening ovary, and then multiplying the quotient by the number of eggs weighed.

ARTIFICIAL FERTILIZATION

Methods and equipment.—Two methods of fertilization were employed; namely, dry and wet. In the dry method the fertilization dish, a finger bowl, was merely moistened with sea water before the eggs and milt were stripped into it. In the wet method the eggs and milt were stripped into the fertilization bowl half-filled with sea water.

In both methods the procedure of stripping the fish was as follows: A ripe female was taken with the left hand and held firmly by the head. The vent was held quite close to the fertilization dish in order to avoid injury to the delicate eggs. Then the right hand was repeatedly smoothed down from the pectoral region towards the vent of the fish until sufficient eggs were obtained.

By the same procedure one or two ripe males were taken and stripped of their milt into the bowl of eggs. Whenever an insufficient amount of milt was taken in one stripping the fish was laid on its side. After about half an hour it was stripped again. The milt from one or two ripe males was often enough to cover and fertilize the eggs from an average female.

Great caution should be observed in stripping, especially when the fish is taken alive. The wounds often inflicted by the sharp dorsal and pelvic spines produce agonizing pain and the bleeding from them might interfere with the fertilization of the eggs.

The eggs and milt collected in the fertilization dish were carefully mixed and stirred with a hen's feather. The mixture was constantly stirred for from ten to fifteen minutes, after which the eggs were rinsed of the excess milt, thoroughly washed by pouring in fresh salt water, which was decanted repeatedly until the water in the fertilization dish was clear.

As there was no hatching apparatus, finger bowls and petri dishes were used for hatching. To provide constant aeration, the water in the hatching dishes was changed as often as possible until the end of the incubation period.

To obviate the difficulty or inconvenience in aërating the eggs by frequent changing of the water, a live or hatching box was constructed in Tagbilaran, Bohol, during the spawning run of April 27–28, 1936. The hatching box consisted of an ordinary wooden box (50 × 30 × 20 cm) provided with a bamboo float

on each side, and the bottom covered with a fine organic cloth. It was set out in the sea and tied at one end to a pole staked into the sand.

The artificial impregnation of the eggs was carried out in the fishing ground. The eggs and milt were stripped from the fish as the latter were taken from the bunuan of the fish corral. The impregnated eggs, after having been thoroughly washed of the excess milt and fairly hardened, were transferred to the hatching box. Their development was observed in the laboratory under a compound microscope.

RESULTS AND DISCUSSION

The dangit are not sexually dimorphic; nevertheless, during the breeding season the sexes may be readily distinguished and separated by the following criteria:

1. The males are generally smaller than the females. Mature males are from 11 to 14 centimeters long and mature females from 13 to 21 centimeters.
2. The abdominal region of the females is more distinctly plump and enlarged than that of the male on account of the ripening ovary.
3. The genital aperture of the female is more enlarged than that of the male for the free passage of the ripe eggs.
4. When slight pressure is applied on the vent region, ripe, orange-colored eggs come out from the female and white milt from the male.
5. In the water the female is less active than the male because of the weight of the ripe eggs.

After stripping a large number of females during the spawning run of March, 1936, two distinct groups of eggs were noted. The ripe eggs are translucent orange, perfectly spherical, demersal and adhesive (Plate 1, fig. 2). They have the tendency to stick or clump together upon the walls of the hatching glass vessel. The reticulated structure of the egg membrane (Plate 1, fig. 2) probably accounts for its adhesive property. The eggs measure about 0.7 millimeter in diameter. At this size most of them are free in the lumen of the ovary and are ready to be spawned, hence they are easy to expel. These eggs flow in a stream from the vent of the fish as the latter is stripped. They are usually encountered during the fifth and sixth nights of the spawning run. During this time also most of the fish caught and examined were ripe and ready for spawning.

The unripe eggs (Plate 1, fig. 1) are usually met with in stray spawners, which appear in the catch of the fish corral, mixed with other fishes, a few days prior to the actual date of the run. However, very few fish bear this kind of eggs. The eggs are characterized by being orange, opaque, quite hard to strip, and flow in clots when stripped.

As to the relative efficacies of the dry and wet methods of impregnation, nothing definite has been determined. In both methods few eggs were hatched, possibly due to poor aëration, the eggs having been hatched only in open finger bowls and petri dishes where a continuous circulation of water was not obtainable. In spite of the frequent changing of the water in these simple hatching dishes to provide sufficient aëration, the eggs clumped together, so that very few were hatched.

The development of the egg, as may be seen in Plate 1, figs. 3 to 11, is typical of that of any teleostean fish. Under ordinary room temperature of 27.5° C. it is relatively fast. The early cleavage stages are not illustrated, for they were not observed; they took place during the transport of the impregnated eggs from the fishing ground to the laboratory.

About twelve hours after impregnation the egg is in the primitive-streak stage. The primitive streak appears as a linear thickening along the anteroposterior axis of the embryonic shield. During this time the head and tail regions are not yet in full evidence.

About fifty-five hours after impregnation the embryo is already fully developed, with the lens and optic vesicles clearly visible. An enlarged oil globule is clearly discernible in the yolk sac.

On the third day, approximately sixty-two hours after impregnation, the young fry is liberated from the eggshell. It measures about 1.5 millimeters in length. It is highly transparent with a few scattered black chromatophores along the ventral fin fold. The head is large and the semiovoid yolk sac is yet discernible, ventral to the head region. Upon liberation the fry begins to swim actively in the hatching dish.

It may be mentioned that even the recently spawned eggs of dangit, collected on the bottom of the terminal pound during the spawning run, were found to hatch in petri dishes after two or three days. These eggs, which were undoubtedly naturally fertilized, could be easily brailed out from the bottom of the pound with a plankton net or a fine-meshed dip net. This

is of prime importance in rescue work for the eggs of dangit and in supplying a hatchery.

The newly hatched fish were transferred to glass jars of 3-liter capacity, which were previously provided with sand and aquatic plants (*Enhalus acoroides* Rich.). But because the fish were fast dying even before the resorption of the yolk, they were all preserved in 5 per cent formalin. The death of the embryos was probably due to lack of sufficient aëration and other factors which are still undetermined.

The use of the hatching box in Tagbilaran, Bohol, for the hatching of the eggs of dangit was quite successful, but very few fry were hatched from the eggs, possibly due to insufficient circulation of water in the hatching box and the clumping together of the eggs. In this hatching box the eggs began to hatch two to three days after impregnation. The newly hatched fry were immediately released in the nursery grounds.

SUMMARY AND RECOMMENDATION

1. The principal fishing as well as the spawning season for dangit in Murcielagos Bay and Bantayan, Bantayan Island, Cebu, is from January to April, inclusive, of each year. In Tagbilaran and vicinity, Bohol, the season falls in January and February.

2. The actual time of spawning varies in different places. It lasts from the fourth to the seventh night after the appearance of the new moon in Bantayan, Bantayan Island, Cebu, and from the fifth to the sixth night of the new moon in Murcielagos Bay and Tagbilaran, Bohol.

3. The dangit female is a very prolific fish, depositing from 300,000 to 400,000 eggs at one spawning.

4. The artificially impregnated eggs hatch in two to three days. The rescued eggs from the spawning ground hatch at the same time as those of the artificially fertilized eggs.

5. The adhesive property of the eggs of dangit appears to reduce the percentage of hatching both in the petri dishes or in the hatching box. This being one of the greatest drawbacks in the hatching of the eggs, it is recommended that starch, swamp muck, and other ingredients that would eliminate this adhesive property of the eggs be tried in an organized hatchery.

6. Other types of hatching boxes that would provide better circulation of water should be experimented with.

7. It is recommended that further studies on the comparative efficacies of the wet and dry methods of impregnation be undertaken.

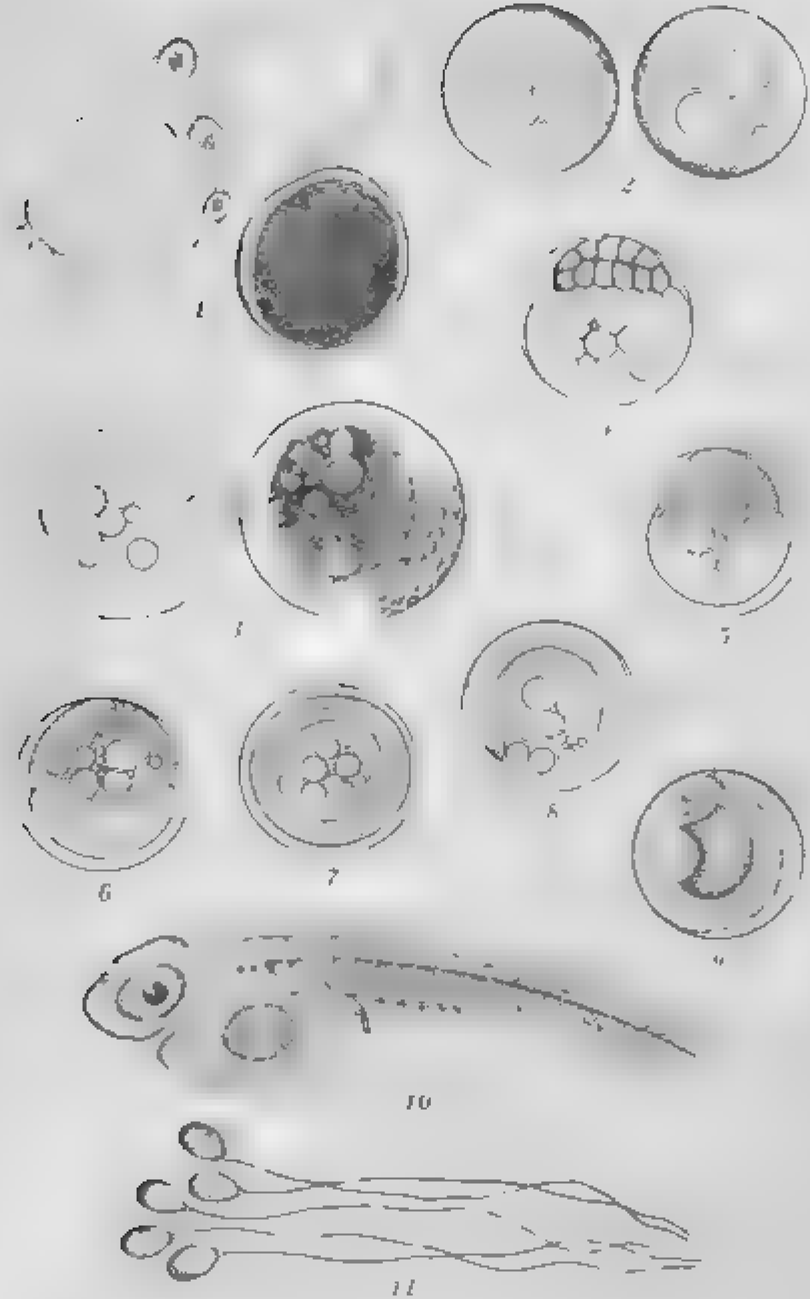
8. For the rehabilitation of the dangit fishery, a hatchery, preferably a floating one, should be constructed so that rescue work and artificial propagation of dangit and other important fishes may be undertaken.

ILLUSTRATION

(Drawings by Pio C. Medel.)

PLATE 1. DANGIT, *Amphacanthus oramin* (BLOCH AND SCHNEIDER)

FIG. 1. Unripe eggs, × 60.
2. Ripe eggs, × 70.
3. Unfertilized eggs, × 60.
4. An egg two and one-half hours after impregnation, × 60.
5. An egg five hours after impregnation, × 60.
6. An egg seven and one-half hours after impregnation (primitive-streak stage), × 60.
7. An egg nine hours after impregnation (germ-ring stage), × 60.
8. An egg twelve hours after impregnation (primitive-streak stage), × 60.
9. An egg fifty-five hours after impregnation, × 60.
10. A newly hatched fish, × 100.
11. Dangit sperms, highly magnified.



PLATE

THE GEOLOGY OF PUERTO GALERA, MINDORO

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THREE PLATES AND ONE TEXT FIGURE

INTRODUCTION

Mindoro has not been studied geologically as much as the other large islands of the Philippines, and the literature on the subject is very limited.

Becker [1] and Smith [2] merely mentioned a few rocks and minerals found on the island by foreign travelers and explorers during the Spanish régime. Merrill [3] and Mearns ascended Mount Halcon in 1906 and recognized the rocks on its summit. Dalburg [4] wrote a short paragraph on the geology of the low alluvial country in the San José Estate, southern Mindoro, and José Nieto y Aguilar [5] gave a brief description of some parts of the island, including Puerto Galera, which is the place treated in the present paper.

The writer visited Puerto Galera in 1933, when the President of the University of the Philippines requested the staff of the Department of Geology and Geography, of which the writer was a member, to make a geological study of it. Another visit was made in the summer of 1935 to complete the data, principally on its physiography, structural geology, and historical geology.

FIELD WORK

A reconnaissance survey was made in the summer of 1933, and a detailed study together with the revision of previous data was carried out in the summer of 1935. The investigation was done mostly along the shores, where excellent exposures of formations are found; some trips towards the interior were made,

[1] Becker, G. F., U. S. Geologic Surv. 21st Ann. Rep. 3 (1901) 18.

[2] Smith, W. D., Geology and Mineral Resources of the Philippine Islands, Manila (1924) 257.

[3] Merrill, E. D., Philip. Journ. Sci. § A 2 (1907) 264.

[4] Dalburg, F. A., Philip. Journ. Sci. § B 9 (1914) 142.

[5] Nieto Aguilar, J., reseña geográfico-geológico-minera de las mismas. Colonización de Filipinas—Madrid, Alonso 12 (1893) 8, pt. 2 50–52.

especially along the rivers and creeks. The writer used as a base map United States Coast and Geodetic Survey chart No. 4344.

Fig. 1. Mindoro Island, showing the area studied (seen in rectangle).

THE PHYSIOGRAPHIC FEATURES OF MINDORO[6]

Mindoro has an area of 9,826 square kilometers and is the seventh largest island in the Philippines. Its topography is characterized by two mountain clusters or masses, the Mount

[6] Faustino, L. A., The Mineral Resources of the Philippine Islands for the years 1924 and 1925 (1926) 33.

Halcon mass on the north and the Mount Baco mass on the south which are separated by a transverse valley. In some places, especially in the northern and western parts, the mountains are very close to the sea and interrupt the coastal plains, which are generally narrow. The greater expanses of these are found in the eastern and southern portions of the island.

The coast of the island is irregular; in some places it consists of coral reefs.

The important rivers are Baco, Baruyan, Calapan, Abra de Ilog, and Subaan on the north; Silonay, Sinabu, Navotas, Cavayan, Pola, Pinamalayan, and Aglubang in the east; Caguray and Bulalacao in the south; and Sinambolan, Batbuayan, Hangpong, and Arunay in the west.[7] The rivers radiate from the mountain masses into the sea.

Lake Naujan, in the northeastern part of the island, is the only lake of importance. It has an area of 70 square kilometers and is estimated to be 20 meters above sea level. Its greatest depth is 15 meters. It is believed to be of volcanic origin.[8]

BRIEF GEOGRAPHIC SKETCH OF PUERTO GALERA

LOCATION AND EXTENT

The area under discussion is about 30 square kilometers, and lies in the northern part of Mindoro between latitudes 13° 29′ and 13° 32′ north and between longitudes 120° 54′ and 121° 00′ east.

ACCESSIBILITY

Puerto Galera is accessible from Manila by either of two routes—(*a*) by railroad to Bauan or Batangas, in Batangas Province, and from there by sailboat; or (*b*) by boat from Manila to Calapan, Mindoro and from there by motorboat. The first is an eleven to sixteen-hour trip, depending on the wind, and the second is about an eighteen-hour trip.

At present this municipality is isolated from the rest of the island by lack of roads, but there is a project to connect Abra de Ilog with Calapan through it. If this is done Puerto Galera will be more prosperous than it now is.

THE PHYSIOGRAPHY OF PUERTO GALERA

Although Puerto Galera is of small areal extent, its features are numerous and varied, due mostly to the lithologic diversity

[7] Census of the Philippine Islands: 1918 1 (1920) 187.
[8] Pratt, W. E. Philip. Journ. Sci. § A 11 (1916) 234.

of its rock formations, the fundamental geologic processes in operation, and its position with reference to the sea.

The region under consideration is located at the foothills of a cluster of mountains—the Baletero, the Malasembo, and the Talipan—which belong to the mountain mass of Mount Halcon. There are in places behind the coves low, flat-lying lands, semicircular in outline and with areas of less than a square kilometer. They are mostly the combined result of marine and stream gradation. One of them is the site of a former lake.

The most striking feature is a plateau, at about the end of the peninsula at Escarceo point. The plateau is almost completely surrounded by steep cliffs.

The approach to the mountain cluster referred to above is in its topographic youth. It is dissected by ravines with rapids and falls debouching on the sides of the bays and coves. At low tide the mouths are shut off from the sea by sand bars, formed by the action of waves and currents. There are no large rivers. The only rivers of importance are the Tabinay and the Lagundian.

Near the shore and on Medio and Boquete Islands,[9] and on Escarceo Peninsula,[10] the topography is rolling, the hills having an even elevation of about 80 meters.

There is no permanent lake in the locality. Mendez de Vigo is said to have found a small, very deep lake which had the smell of sulphur and was suspected of being a crater,[11] but this lake cannot be found at present, nor do the inhabitants know of any lake, except a depression filled with water during the rainy season. This depression is behind Laguna Cove, and is believed by the writer to be the bottom of a dried lake. It is divided by a slight elevation, so that two lakes are formed when the level of the water is not high.

There are swamps south and southwest of the town, at the mouth of Tabinay River and in Sigayan Cove. The first two are nipa swamps, and the last is a mangrove swamp. None of them is extensive.

[9] The island marked Paniquian on U. S. Coast and Geodetic Survey map No. 4344 is known as "Boquete" to the people. They give the name "Paniquian" to a point in Medio Island which projects into the Manila or Northwest Channel.

[10] The peninsula is here called "Escarceo" from a point at its extreme end.

[11] Becker, G. F., U. S. Geologic Surv. 21st Ann. Rep. 3 (1901) 45.

At the Tabinay Na Malaki are two springs, one of which is thermal with a temperature of 33.3° C. A cool spring is reported at Baletero. Favorable artesian circulation is undoubtedly responsible for these, as they are found in limestone formations. The temperature of the warm spring may be attributed to contact with deep-seated igneous rocks still in the process of cooling.

There are two bays, Puerto Galera and Varadero, and numerous coves, which together with the islands and promontories make the coast line very irregular. Coral reefs, mostly fringing, abound along the shore with living specimens in the surrounding waters. Elevated beaches and wave-built terraces are very conspicuous in some of the coves.

The following are the important features in the physiography of Puerto Galera:

1. The absence of extensive plains. Narrow strips of coastal plain are wanting.
2. The plateau in Escarceo Peninsula.
3. Absence of large rivers. The streams usually debouch on the sides of the bays and coves. Their mouths are usually shut off from the sea by sand bars during low tide.
4. The rolling topography in Boquete and Medio Islands and in Escarceo Peninsula.
5. The general sameness of elevation of the hills in these places.
6. The presence of a dried lake, probably of volcanic origin.
7. The presence of swamps.
8. The presence of cool and thermal springs.
9. The presence of elevated beaches or wave-built terraces.
10. The irregularity of the coast line enhanced by coral reefs, mostly fringing.

RELATION OF TOPOGRAPHY TO STRUCTURE

The ruggedness and great relief adjoining the mountain cluster is due mainly to the attitude of the metamorphic rocks brought about by deformation—intrusions and extensive jointing. Partly responsible is also the presence of marble and limestone, which are weathered by rain water.

The points and projections of land into the sea usually terminate in serpentine rocks that are fairly resistant to erosion. They are lenticular intrusions from which the overlying for-

mations have been removed by denudation. Thus they form hills and contribute to the irregularity of the coast

Calcareous and somewhat tuffaceous shales, sandstones, and limestones were subjected to gentle warping. Their attitude points to the existence of a dome fold that has been affected by faulting and erosion.

In some cases the slope of the land has the same direction as the inclination of the strata, although the first has always been found to have a greater angle. The steep cliffs represent fault scarps. The rolling topography is due to differential erosion.

GEOLOGIC FORMATIONS

IGNEOUS

On two occasions the writer encountered small outcrops of what he believes to be the basal rocks and, therefore, the oldest in the area under consideration. These consisted of coarsely crystalline granodiorite and granite (localities 7 and 51) with abundant quartz and feldspar. The granodiorite is flesh-colored in parts, and in other parts, white due to quartz and decomposing feldspars. The granite is white and speckled with hornblende and mica.

Merrill says that Mount Halcon is a mass of granite, white quartz, schist, and marble,[17] although Smith claims to have identified some of these rocks as andesite.[18] Probably Smith found some andesite among the rocks collected by Merrill. If these findings are true, then Puerto Galera and Mount Halcon have the same formation and they may have also the same geologic history.

The granite in Mount Halcon may be the same as that found in Lubang Island by Elcaño.[19]

The writer suspects that the granodiorite and the granite that he found in Puerto Galera are contemporaneous with those found by Alvir in Bulacan Province and classified by him as early Paleozoic.[20]

THE METAMORPHIC ROCKS

Puerto Galera formation (schist and gneisses).—The metamorphic rocks are gneisses, schist, and marbles. The gneisses

[17] Merrill, E. D., Philip. Journ. Sci. § A 2 (1907) 256.

[18] Smith, W. D., Geology and Mineral Resources of the Philippine Islands, Manila (1924) 256.

[19] Op. cit. 269.

[20] Alvir, A. D., Philip. Journ. Sci. 40 (1929) 399.

possess both the banded and the lenticular texture. The gneisses and also the schists were metamorphosed from the granodiorite and granite. This is evidenced by the superposition of the schists and gneisses, and the fact that they contain muscovite, biotite, and feldspars. Their color is a light brownish gray. On the other hand, the carbonates associated with the schists and gneisses indicate their sedimentary origin. The metamorphics in this locality may therefore be of dual origin—igneous and sedimentary—the latter predominating over the former. Those of igneous origin are the granite gneisses and those of the sedimentary, marbles (impure limestones).

The schists are of two types. One of them liberates carbon dioxide when treated with hydrochloric acid, while the other does not have this reaction. The former, together with some specimens in which marbles are included between the folia, denotes either impurity of sediments at the time of metamorphism or deposition by percolating water. It is this fact that makes the writer believe that the majority of the schists, and, in fact, most of the metamorphics, are of sedimentary origin.

Some, however, are derived from serpentine and other secondary minerals, as chlorite and talc, which usually compose it.

The predominating schists are sericite, chlorite, and serpentine. They are green of varying shades. Phyllite encountered in the weathered condition is merely a phase of schist. It appears also to be of sedimentary origin.

Metamorphic rocks are also found in other localities of the Philippines, as in Ilocos Norte, Camarines Norte, Caramoan Peninsula, Cebu, Zamboanga, Surigao, Palawan, and Romblon;[16] but their age is uncertain. Masó and Smith believe them to be Tertiary.[17] Romblon[18] may be an exception because of the similarity of its rock formations and its proximity to Mindoro.

As no equivalent of this formation is known with certainty in the Philippines, the writer proposes to call the schists and gneisses the Puerto Galera formation, to conform with Alvir's Zamboanga formation in his table of Philippine Stratigraphy[19] and were it not for the fact that this term is not recognized,

[16] Smith, W. D., Philip. Journ. Sci. § A 5 (1910) 324.

[17] Masó and Smith, Philip. Journ. Sci. § A 8 (1913) 281.

[18] Adams, G. I., Philip. Journ. Sci. § A 4 (1909) 87.

[19] Alvir, A. D., Synopsis of Lectures in Physiography, Part II, table 2. Technology Cooperative Co., Manila (1928).

the same nomenclature could have been applied to avoid the naming of too many formations, which results in confusion in the established geologic column of the Philippines.

Romblon formation? (*marbles*).—This formation consists of fine-grained, compact rocks of varying colors—white to yellow-banded gray. The rocks are in massive blocks, possibly due to jointing, and are badly weathered. In this as in other regions, they are associated with the schists and gneisses and the same remarks can be made on them.

Cinco Picos formation? (*serpentines*).—In some points along the coast serpentines can be seen. They are intrusions in the form of lenses into the metamorphic rocks. They have been laid bare by erosion, and are doubtless the same serpentines as those found by Elicaño in Lubang and Golo Islands.[20]

There is no way of estimating the thickness of these metamorphic-rock formations as they are badly contorted and jointed and are further complicated by erosion.

THE SEDIMENTARIES

The basal conglomerate.—This conglomerate is made up of particles or pebbles of quartz, marble, schists, and the serpentines described above. It is so indurated and compact that when hammered it does not break off between the pebbles as most conglomerates, but rather at its own fracture. This rock has a very limited distribution.

One specimen was encountered just below the shales at Boquete (locality 28) and another as a float in Minulu Point (locality 13). This limited distribution suggests its mode of occurrence, that is, in the form of lenses, otherwise the stratum could be traced for distances. It also indicates the conditions under which the formation of this conglomerate took place, a subject discussed below under geologic history.

Because of the position of this conglomerate with reference to the other rocks, and because of its physical character, the writer believes it to be old, possibly Eocene. It may be contemporaneous with the conglomerate that Smith describes to be of varying thickness and containing fragments of practically all the other rocks—diorite, andesite, schist, and slate. He places this at the base of the Tertiary.[21]

[20] Smith, W. D. Geology and Mineral Resources of the Philippine Islands. Manila (1924) 260.

[21] Op. cit. 76.

Alpaco formation? (*shales and sandstones.*)—The shales are tuffaceous and marly. Some possess the grayish color of volcanic tuffs, and may easily be mistaken for these. Others range from buff to yellow. They are fine-grained and stratified. The buff and yellow strata that are usually found on the higher portions of the formations are sometimes interstratified with a brownish red, coarser material that is more resistant. On the lower portions the shale is interstratified with fine-grained sandstone. The probable thickness of this formation is about 200 meters. These shales are mostly confined to Boquete and Medio Islands and Escarceo Peninsula, where they lie unconformably on the metamorphics.

Limestones.—The limestones are coralline and fossiliferous The fossils found in them can still be found as living species In fact these formations are continuous with living coral reefs found in the waters of the locality. Among the fossils are pecten, oysters, and various kinds of colonial and individual corals broken in small pieces and cemented together.

This formation is stratified in places and in others it is massive. The beds are about one hundred meters thick and lie unconformably on the shales. At the base of some of the limestone cliffs can be found conglomerates made up mostly of the shells of marine invertebrates. These conglomerates are of the same age as the limestone formation

Alluvial and other recent deposits.—These deposits are best developed at the depressions behind the coves or bays. They consist of soils derived from the surrounding rocks, mostly metamorphics near the mountain mass, and shales and limestones on the islands and the peninsula. Along the shores are found quartz sands and gravels or limestone sands and gravels, depending on the parent rock. There are also places along the coast, as along Tabinay, where the broken, rather flat pebbles of schists are found. These pebbles have assumed oval or elliptical shapes due to wave action. Lacustrine deposits are encountered where the lake mentioned above existed.

GEOLOGIC STRUCTURE

As previously noted, this area is located at the foothills of one of the mountain clusters or masses (Mount Halcon cluster) of the island. The metamorphic rocks overlie the granite and granodiorite. The former is slightly arched and broken due probably to later intrusions of basic igneous rocks. In some

cases these are lenticular and have been altered into serpentines. Some exposures of the metamorphic rocks show contortions.

Elicaño[22] stated with regard to the relation of the rock formations in Lubang Island:

From the data in hand it seems that the serpentine constitutes the basal formation over which the metamorphosed sedimentaries were laid during the period of submergence of the former. Probably contemporaneous with the formation of the coral beds or preceding it, the intrusion of the granite metamorphosed the sediments into their schistose forms, and the subsequent elevation of the region brought up the coraline formation to the present state.

With this view the present writer is unable to agree, largely because of the fact that these rocks show very extensively the effect of dynamic metamorphism.

The shales are the next formation of importance in the structure of the region, the basal conglomerates mentioned in a previous paragraph being found only in lenticular patches. These do not seem to have suffered great deformation.

As can be seen in the accompanying sections, the shales are unconformable on the underlying metamorphics and on the overlying limestones. The limestones were in some cases subjected to the same agents as the shales, and therefore show almost the same attitude. In most cases, however, they occur in massive forms that have never been disturbed.

The faults are minor and local in character and cannot be traced to any major fault, but they may be the effect of a great fault or faults.

GEOLOGIC HISTORY

PALÆOZOIC HISTORY

Before the Permian period, when this region was still under water, there were local intrusions of granite and allied rocks and small amount of granodiorite in the Philippines. Mindoro, at least the part where Puerto Galera is located, must be one of the sites of these intrusions. Lubang Island, which is not far from Mindoro, has some granite and must have similar intrusions. The granite and granodiorite found in the area studied must belong to the same age as that of Lubang, because of their proximity and their similarity.

In the later part of the Palæozoic, during the Permian revolution, the depression of the China Sea occurred, and contem-

[22] Smith, W. D., Op. cit. 259.

poraneous with it the intrusions of basic igneous rocks which form the skeletal framework of the Archipelago. These marked the position of the islands and formed the major tectonic axes.

MESOZOIC HISTORY

The Mesozoic history of the Philippines is somewhat obscure, especially when dealing with the metamorphic rocks, as their relation with other rock formations has not been definitely established

The ultra basic intrusions throughout the Philippines, which are recognized in Puerto Galera in the altered form, the serpentines, belong to the Cretaceous. They are found intruded into the Triassic schist and gneisses.

Fine sediments were being deposited at the beginning of the Mesozoic In the later part of the Triassic these, together with the rocks on which they rested, were metamorphosed. This process simply represents another revolution, although perhaps very much less than the preceding Permian revolution Localities other than Mindoro were undoubtedly affected by it.

The Jurassic, which is very limited in distribution, and the Comanchean, a probable missing chapter in the Philippine Mesozoic were not encountered or recognized in the field so that the Cretaceous naturally follows.

This last period of the Mesozoic in the Philippines was characterized by the ultrabasic intrusions, and in Puerto Galera these are represented by serpentines, the altered products of such rocks. There must have been an uplift contemporaneous with these intrusions or possibly inaugurating the opening of the next period.

TERTIARY AND POSTTERTIARY HISTORY

At the beginning of the Cenozoic the topography of Puerto Galera must have had characteristics similar to that of today as the conglomerate is discontinuous. It was either formed in an irregular coast line with inclosed bodies of water, or erosion must have been great at the time it was brought above water.

This part of Mindoro must not have been affected by other events taking place in the Philippines in the following periods, the formations of which are not represented This region must have maintained its position above water continually up to the close of the Miocene. This hypothesis is in perfect agreement with the fact that the removal of the great thickness of meta-

morphic rocks necessary to give the place its present surface configuration would involve a long time.

At the close of the Miocene the area submerged very slowly, giving time for the formation of shale deposits. At times during the succeeding period volcanic explosions must have taken place not far from this neighborhood, as the shales are tuffaceous. Then this region emerged at about the end of the Pliocene, only to be under water in the *Pleistocene*, when the coral reefs were forming.

These coral formations and the shales were only slightly affected by diastrophic movements at the time, and a slow but continuous uplift, amounting to a little more than one hundred meters, took place up to the present.

ECONOMIC GEOLOGY

While there are plenty of minerals in the area, it can generally be stated that they do not exist in sufficient amounts to warrant their exploitation.

The marble appears to be of good quality, but as it is badly broken and weathered, it is not worth quarrying. Romblon, which is near Mindoro, has been worked, so that those interested in marble can look to this island for their supply.

Magnesites are found in veins in serpentine rocks. A very small deposit of limonite was seen in the same rock. An incomplete gradation into chromite was also encountered. Gold is reported to have been found in the sands of Taunay River.

With the exception of this last metal, the working out of these minerals seems to be a losing undertaking, at least until more intensive prospecting has been done.

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